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Form C02

(June 2020)

The ACT®

2019 | 2020

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If you wish to order a photocopy of your scanned answer document—including, if you took the writing test, a copy of your written essay—please use the order form on the inside back cover of this booklet.

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ENGLISH TEST

45 Minutes—75 Questions

DIRECTIONS: In the five passages that follow, certain words and phrases are underlined and numbered. In the right-hand column, you will find alternatives for the underlined part. In most cases, you are to choose the one that best expresses the idea, makes the statement appropriate for standard written English, or is worded most consistently with the style and tone of the passage as a whole. If you think the original version is best, choose "NO CHANGE." In some cases, you will find in the right-hand column a question about the underlined part. You are to choose the best answer to the question.

You will also find questions about a section of the passage, or about the passage as a whole. These questions do not refer to an underlined portion of the passage, but rather are identified by a number or numbers in a box.

For each question, choose the alternative you consider best and fill in the corresponding oval on your answer document. Read each passage through once before you begin to answer the questions that accompany it. For many of the questions, you must read several sentences beyond the question to determine the answer. Be sure that you have read far enough ahead each time you choose an alternative.

PASSAGE I

Yukigassen: Snow Big Deal

[1]

Fans in parkas, gloves, and hats surround the snowy field, cheering as their[1] teams line up. [A] Players lob and fling snowballs at their opponents while trying to avoid getting hit. This is Yukigassen—a competitive snowball fight that combines elements of dodge ball and capture the flag.[2]

[2]

Every year, thousands of people flock to the small Japanese town of Sobetsu for the Showa-Shinzan International Yukigassen tournament. Fewer than thirty years ago, though, only a little[3] visitors ventured to this mountainside town during its harsh winters. [B] Hoping to generate year-round tourism, community members created a unique winter sport: *Yukigassen* ("snow battle"). [C]

1. The writer wants to emphasize the fans' loyalty to the teams they have come to watch. Which choice best accomplishes that goal?
   - **A.** NO CHANGE
   - **B.** competing
   - **C.** two
   - **D.** the

2. If the writer were to delete the underlined portion (adjusting the punctuation as needed), the essay would primarily lose a comparison that:
   - **F.** references other games in order to predict how widespread Yukigassen is likely to become.
   - **G.** helps introduce the game of Yukigassen by referencing games that might be more familiar.
   - **H.** indicates that many people are becoming interested in learning to play Yukigassen.
   - **J.** provides details about the rules Yukigassen shares with other games.

3. **A.** NO CHANGE
   B. then thirty years ago, though, only a little
   C. than thirty years ago, though, only a few
   D. then thirty years ago, though, only a few

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[3]

Yukigassen is played on a rectangular field with a wall of snow, called a "shelter" in the center.[4]

On both sides of the field stands[5] other shelters—two that are used for cover and a centered back shelter (the "chateau"), where snowballs are stored. Each team's flag is planted in front of it's[6] chateau.

[4]

Yukigassen games have three periods that each last three minutes. To win a period, teams can grab the opponents' flag, eliminate every player,[7] on the other team, or have more players in the game when the period ends. The team that prevails in two of three periods[8] wins the game.

[5]

Each Yukigassen team has seven players: four forwards and three defensive players. Forwards advance to the center of the field that's[9] crouching behind shelters and trying to eliminate opponents by hitting them with snowballs. Meanwhile, defensive players supply his or her[10] forwards with ammunition and bombard opponents from afar. Any player can attempt to snatch the other team's flag. Defensive players ensure forwards have snowballs[11] to throw.[11]

[6]

In 1989, the first Yukigassen tournament drew[12] 7,000 spectators and seven teams.

4. F. NO CHANGE
   G. snow, called a "shelter,"
   H. snow called a "shelter,"
   J. snow; called a "shelter,"

5. A. NO CHANGE
   B. is standing
   C. has stood
   D. stand

6. F. NO CHANGE
   G. teams' flag is planted in front of its
   H. team's flag is planted in front of its
   J. teams flag is planted in front of it's

7. A. NO CHANGE
   B. flag, eliminate every player
   C. flag; eliminate every player
   D. flag eliminate every player,

8. F. NO CHANGE
   G. prevails, in two of the three periods,
   H. prevails in two, of the three, periods
   J. prevails, in two of the three periods

9. A. NO CHANGE
   B. field, which is
   C. field,
   D. field

10. F. NO CHANGE
    G. that person's
    H. one's
    J. their

11. A. NO CHANGE
    B. Capturing the flag is one way to win a period in Yukigassen.
    C. Players who are hit by snowballs are eliminated.
    D. DELETE the underlined portion.

12. F. NO CHANGE
    G. manifested
    H. persuaded
    J. culled

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When a number of years passed, 28,000 spectators
13
came to watch 190 teams battle in the snow. [D] With the addition of tournaments in Europe, Australia, and the United States, Yukigassen is on the rise, encouraging visitors to enjoy Sobetsu despite the cold.
14

13. At this point, the writer wishes to stress that Yukigassen has grown in popularity in a relatively short amount of time. Which choice best accomplishes that goal?
    - **A.** NO CHANGE
    - **B.** After more than a decade,
    - **C.** Only fifteen years later,
    - **D.** In time,

14. Which choice best concludes the paragraph and the essay by emphasizing Yukigassen's continuing growth?
    - **F.** NO CHANGE
    - **G.** proving that creativity is a great way to stimulate tourism.
    - **H.** accumulating more teams and fans every year.
    - **J.** turning snowball fights into a legitimate sport.

Question 15 asks about the preceding passage as a whole.

15. The writer wants to add the following sentence to the essay:

    A referee blows the starting whistle.

    The sentence would most logically be placed at:
    - **A.** Point A in Paragraph 1.
    - **B.** Point B in Paragraph 2.
    - **C.** Point C in Paragraph 2.
    - **D.** Point D in Paragraph 6.

PASSAGE II

A Stroll Through History on Sweet Auburn

In the early 1900s, when Auburn Avenue in
16
Atlanta, Georgia, became an interesting location for
17
African American business and culture. Jim Crow laws forced segregation of blacks and whites in Atlanta, resulting in the confinement of African
18
American homes and businesses to a small downtown area in the Old Fourth Ward. Over time, African American businesses congregated in this ward besides
19
approximately one and a half miles of Auburn Avenue.

16. **F.** NO CHANGE
    - **G.** During the early 1900s,
    - **H.** The early 1900s, when
    - **J.** Early in the 1900s, as

17. Which choice best emphasizes the activity and success of Auburn Avenue?
    - **A.** NO CHANGE
    - **B.** a location where you could find places of
    - **C.** a thriving center of
    - **D.** a home for

18. **F.** NO CHANGE
    - **G.** Atlanta. The result being
    - **H.** Atlanta, this resulted in
    - **J.** Atlanta, the result was

19. **A.** NO CHANGE
    - **B.** along
    - **C.** between
    - **D.** among

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The area's prosperity and autonomy of the area led to
20

the neighborhood being known as "Sweet Auburn." [21] Three financial companies provided the base for the rise of the black middle class in this area of Atlanta.

Alonzo Herndon, a former slave became a successful
22

barber, founded Atlanta Life Insurance. By its one
23

hundredth anniversary in 2005, the enterprise was worth over 200 million dollars. In 1911, a second black insurance company, Standard Life Insurance, was formed by Heman Perry. Ten years later, Perry founded the Citizens Trust Bank, which offered loans to African American entrepreneurs. Supported by these institutions, small businesses helped Sweet Auburn emerge as a center of black commerce.

In the 1920s and '30s, more than one hundred black-owned businesses, having found their home
24

in the vibrant culture of Sweet Auburn. The avenue

flourished the legendary soul food restaurants
25

Ma Sutton's, you could eat this food at Hawk's
26

Dinette. Entertainment venues such as the Top Hat Club (later the Royal Peacock) hosted famous performers.

20. **F.** NO CHANGE
G. area's well-to-do affluence
H. affluent prosperity
J. affluence

21. At this point, the writer is considering dividing the paragraph into two. Should the writer make this division here?

A. Yes, because it would separate the general discussion of the Old Fourth Ward from the more specific discussion of the one and a half miles of Sweet Auburn.
B. Yes, because it would separate the overview of Sweet Auburn from the discussion of specific companies that helped make Sweet Auburn a success.
C. No, because it would separate the description of Sweet Auburn's financial businesses from the description of its cultural establishments.
D. No, because it would separate the discussion of Sweet Auburn as it is today from the description of its history.

22. **F.** NO CHANGE
G. achieved the goal of becoming
H. acquired the status of a
J. and a

23. **A.** NO CHANGE
B. there
C. it's
D. its'

24. **F.** NO CHANGE
G. businesses, which
H. businesses that
J. businesses

25. **A.** NO CHANGE
B. displayed
C. featured
D. showed

26. **F.** NO CHANGE
G. Sutton's, such food was available at
H. Sutton's and this was also at
J. Sutton's and

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The *Atlanta Daily World*, for instance, the first successful black-owned US daily newspaper, also began on Auburn Avenue.

27. A. NO CHANGE
B. therefore,
C. however,
D. DELETE the underlined portion.

Sweet Auburn's designation: in 1976 as a National Historic Landmark resulted from the neighborhood's cultural strengths and business assets as well as its social values. Civic organizations and historic churches, such as Ebenezer Baptist Church, where Dr. Martin Luther King Jr. preached with his father—all contributed—to establishing Auburn Avenue as one of the most important streets in US history.

28. F. NO CHANGE
G. designation in 1976,
H. designation in 1976
J. designation, in 1976

29. A. NO CHANGE
B. father—all contributed
C. father, all contributed
D. father all contributed

Question 30 asks about the preceding passage as a whole.

30. Suppose the writer's primary purpose had been to provide historical background on a specific urban area. Would this essay accomplish that purpose?
F. Yes, because it outlines the people, institutions, and social and cultural factors that contributed to the rise in importance of Sweet Auburn.
G. Yes, because it explains that the city of Atlanta became nationally recognized for its government-sponsored efforts to promote Sweet Auburn.
H. No, because it focuses on how the community benefited from Sweet Auburn's success rather than on how Sweet Auburn was established.
J. No, because it focuses primarily on three prominent Sweet Auburn businesses rather than on discussing Sweet Auburn in larger terms.

PASSAGE III

An East Coast Epiphany

Meadows of Dan. Peaks of Otter. Fancy Gap. Thunder Ridge. To read about the Blue Ridge Parkway, the most visited "unit," of the national park system, is to enter the realm of colorful language. But I knew better than to fall for the hype of brochures and Web sites preparing to embark on a 469-mile bike ride the length of the parkway.

31. A. NO CHANGE
B. most visited "unit"
C. most visited, "unit"
D. most, visited "unit"

32. F. NO CHANGE
G. in preparation
H. as I prepared
J. I prepare

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Well, I would lend an ear to some of the sweet talk: vistas of gently rolling farmland, swinging footbridges, mist rising from the Roanoke River are breathtaking.
33

I did, in fact, want to find myself face-to-face with a red-eyed vireo and smell a rhododendron in full bloom. Color. History. Twenty-seven tunnels, one named "Frying Pan." Sign me up! Maybe even a black bear would cross the winding pavement's road
34
in front of me. But I was not going to expect perfection. I was not going to expect the pancakes to be hot at Bluffs Coffee Shop or the entertainment to be under way at the music center.
35
I would approach this experience with the wisdom I had acquired at places like Zion National Park,

a glorious park in southern Utah.
36

But here's the thing and the
37
cynic in me perished on the Blue Ridge Parkway, on that two-week ride along the Appalachian Mountains of Virginia and North Carolina. The pancakes were hot. The Meadows of Dan were meadowy. Mabry Mill—its waterwheel spinning and its one-hundred-year-old loom looming—
38
deserves the postcard attention they have
39
gotten all these years.

33. A. NO CHANGE
B. takes away your breath.
C. is breathless.
D. DELETE the underlined portion and end the sentence with a period.

34. F. NO CHANGE
G. road of the pavement
H. paving of the road
J. road

35. Which choice is most specific and most consistent with the level of detail in the rest of the sentence?
A. NO CHANGE
B. Red Stick Ramblers to be performing as scheduled at the Blue Ridge Music Center.
C. experiences we might enjoy to come along at the right time and place.
D. the scheduled event to take place.

36. Given that all the choices are accurate, which one best reflects the narrator's attitude as expressed up to this point in the essay and sets up a key element of the essay's concluding contrast?
F. NO CHANGE
G. where bad weather cut short the hike my brother and I had planned to the famous "Subway," a remote canyon bright with neon colors.
H. where a shuttle service was successfully implemented to cut down on that park's vehicular traffic, which had become a serious problem.
J. a spectacular setting that draws visitors from around the nation and the world.

37. A. NO CHANGE
B. thing: the
C. thing the
D. DELETE the underlined portion.

38. F. NO CHANGE
G. looming:
H. looming,
J. looming

39. A. NO CHANGE
B. we have
C. it has
D. its

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Seeing me, too, I saw a bear. And not only were the
40

rhododendrons blooming, so is the bluets and the foam
41

flowers. [42] Sometimes everything that should go

right did. Sometimes the fragrant thimbleberry is
43

fragrant and the sign on the road really does say, "Next
44
20 miles, *All Downhill!*" Okay, the sign part is made-up, but the downhill was real. Southern Utah's "Subway" remains an elusive mystery. The Blue Ridge Parkway, as seen from my bike anyway, is a 469-mile miracle.

40. **F.** NO CHANGE
G. Being seen by a bear, the bear saw me.
H. The sight of a bear, which saw me too.
J. I saw a bear. A bear saw me.

41. **A.** NO CHANGE
B. will be
C. were
D. had

42. At this point, the writer is considering adding the following true statement to the essay:

> Former US Secretary of the Interior Harold Ickes was a key player in the creation of the parkway.

Should the writer make this addition here?

F. Yes, because it answers a question raised by the narrator earlier in the essay.
G. Yes, because it provides a logical transition to the essay's conclusion about the parkway's history.
H. No, because it disrupts the flow of the paragraph and departs from the established tone of the essay.
J. No, because it suggests the narrator read about the parkway before riding it, which the rest of the essay does not support.

43. **A.** NO CHANGE
B. does.
C. is.
D. DELETE the underlined portion and end the sentence with a period.

44. Which choice results in a statement that best supports the point made in the preceding sentence?

F. NO CHANGE
G. crowded out by noxious weeds
H. hard to see
J. wilted

Question 45 asks about the preceding passage as a whole.

45. Suppose the writer's primary purpose had been to write in a lighthearted fashion about an experience of gaining some self-knowledge. Would this essay accomplish that purpose?

A. Yes, because the essay reveals the narrator playfully exploring a cynical side of herself that disappears on a trip on the Blue Ridge Parkway.
B. Yes, because the essay establishes that the narrator enjoyed the company of other bike riders on the Blue Ridge Parkway.
C. No, because the essay indicates that a trip to Zion National Park was more satisfying for the narrator than a later trip to Blue Ridge Parkway.
D. No, because the narrator describes herself as the opposite of lighthearted, even after a trip that was supposed to have changed her outlook.

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PASSAGE IV

Noether's Theorem

[1]

Laws of conservation—the idea that, within a physical system, certain measurable properties such as energy or momentum can neither be created nor destroyed—are (46) fundamental to physics. When properties are conserved, they never leave the system. Therefore, physicists can study them and predict how even complex systems will behave. (47)

[2]

Laws of symmetry, however, (48) are valuable for the same reason: (49) predictability. If a physical system behaves the same way regardless of how it's orientated in space, than (50) it's symmetric. If, for instance, an experiment yields the same result whether it is conducted in the United States on Tuesday or in India on Thursday, which has (51) symmetry of space and time. [52]

[3]

The relationship between conservation and symmetry had been overlooked, though, prior to the publication of Amalie Noether's theorem in 1918. Noether, a German mathematician, found that where there is symmetry in nature, there is corresponding conservation. Noether devised a groundbreaking set of equations to apply to symmetrical systems. [A] A bicycle wheel is radially symmetrical: you can spin it on its axis and it looks

46. **F.** NO CHANGE
G. has been
H. were
J. is

47. **A.** NO CHANGE
B. behave, as physicists study them.
C. have behavior they can predict.
D. behave and act out.

48. **F.** NO CHANGE
G. symmetry, in the same way,
H. symmetry, besides,
J. symmetry

49. **A.** NO CHANGE
B. reason, that is
C. reason;
D. reason

50. **F.** NO CHANGE
G. orientation in space, then
H. oriented in space, then
J. orient in space, than

51. **A.** NO CHANGE
B. those will have
C. they have
D. it has

52. If the writer were to delete the preceding sentence, the paragraph would primarily lose a:

F. scenario that demonstrates why experiments are often conducted multiple times.
G. hypothetical example that explains the physics concept of symmetry.
H. demonstration of how physicists study space and time.
J. summary of one of the discoveries Noether made.

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the same from any direction. Applying Noether's theorem reveals that the wheel conserves angular momentum the property that keeps bicycles upright, [53] and moving forward. [B]

[4]

Both conservation laws, and laws of symmetry predict, [54] and explain how systems behave. Thus, knowing that conservation exists where there is symmetry creates a whole new set of information about physical systems. Including, [55] details about the properties within them that ultimately affect [56] how the system works. [C]

[5]

The significance of Noether's theorem has not been lost, but her name has. Dubbed "the greatest mathematician you've never heard of," Noether, until recently, [57] was not widely recognized for her accomplishments. [D] Her name may not be as familiar as those of Einstein and Newton, but her theorem being regularly used [58] in modern physics.

Finally, [59] in 1928, Noether accepted a teaching position at Moscow State University.

53. A. NO CHANGE
    B. momentum—the property that keeps bicycles upright—
    C. momentum; the property that keeps bicycles upright
    D. momentum, the property that keeps bicycles upright

54. F. NO CHANGE
    G. laws, and laws of symmetry, predict
    H. laws and laws of symmetry predict,
    J. laws and laws of symmetry predict

55. A. NO CHANGE
    B. systems. Which include
    C. systems, including
    D. systems including,

56. F. NO CHANGE
    G. which ultimately effects
    H. whose ultimate affect
    J. that ultimately effect

57. A. NO CHANGE
    B. until most recent,
    C. of most recently,
    D. before recent,

58. F. NO CHANGE
    G. having been regularly used
    H. to be used regularly
    J. is regularly used

59. Which of the following would be the best decision by the writer regarding the underlined portion?
    A. Leave it as the final sentence of the essay because it provides a logical conclusion.
    B. Move it to the beginning of this paragraph because it introduces the paragraph's focus.
    C. Delete it, because it contradicts the idea that Noether was recognized in small circles for her accomplishments.
    D. Delete it, because it concludes the essay by introducing a new topic that is only loosely related to the main topic of the essay.

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Question 60 asks about the preceding passage as a whole.

60. The writer wants to add the following sentence to the essay:

> Entrenched in a field that was unwelcoming to women, Noether often published her papers using a male pseudonym.

The sentence would most logically be placed at:

F. Point A in Paragraph 3.
G. Point B in Paragraph 3.
H. Point C in Paragraph 4.
J. Point D in Paragraph 5.

PASSAGE V

Now I've Seen the Mall

[1]

[1] Austrian architect, Victor Gruen (61) had a vision for US retail stores. [2] Another problem was that the distances between retail stores forced shoppers to drive, not walk. [3] A native of Vienna, there was a downtown filled with pedestrians near the (62) place where Gruen had grown up. (62) [4] He loathed the flashy signs that stretched mile after mile along the streets in the 1950s. [5] There, whether looking for a gift or some fresh air, people could more readily interact with neighbors and friends. [6] This type of casual, friendly shopping experience was what he sought to bring to America. (63)

61. **A.** NO CHANGE
B. architect, Victor Gruen,
C. architect Victor Gruen,
D. architect Victor Gruen

62. **F.** NO CHANGE
G. a downtown filled with pedestrians was near the place where Gruen had grown up.
H. Gruen had grown up near a downtown filled with pedestrians.
J. pedestrians filled the downtown near Gruen's childhood home.

63. For the sake of logic and cohesion, Sentence 4 should be placed:

A. where it is now.
B. after Sentence 1.
C. after Sentence 2.
D. after Sentence 5.

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[2]

His chance came in 1952 when he was hired to design a shopping center in Minnesota. Gruen conceived of an 800,000-square-foot structure that had two levels of stores encircling a roofed central area. Arranging the stores to face inward, Gruen created a mostly blank exterior and he created an interior where businesses could advertise. Although the space between stores was indoors, the air temperature could be controlled to ensure that customers wouldn't be bothered by the elements. There was a café, a fountain, an aviary, and even a small zoo. Southdale Center was revolutionary. [A]

[3]

Reporters from across the country flocked to the 1956 grand opening of Southdale, and 75,000 customers came and saw the many stores and parking spaces. The design dazzled reporters. The convenience delighted shoppers. Businesses found the profits thrilling.

64. Given that all the choices are accurate, which one provides the best transition to the opportunity discussed in the paragraph?
    - F. NO CHANGE
    - G. 1952 after he had created several eye-popping storefronts in New York City.
    - H. 1952; he had previously established his own architectural firm.
    - J. 1952—just fourteen years after he had arrived in the United States.

65. A. NO CHANGE
    B. exterior, he also designed
    C. exterior and
    D. exterior; also

66. F. NO CHANGE
    G. Because
    H. Before
    J. Until

67. Which choice most clearly emphasizes that the grand opening was exciting and attracted a large number of reporters?
    - A. NO CHANGE
    - B. gathered at
    - C. traveled to
    - D. attended

68. The writer is considering revising the underlined portion to the following:

    gawked at the seventy-two stores and abundant free parking.

    Given that the information is accurate, should the writer make this revision?
    - F. Yes, because it more clearly states the number of people at Southdale's grand opening.
    - G. Yes, because it more clearly indicates why Southdale impressed the crowd.
    - H. No, because it suggests that the crowd was unfamiliar with a shopping center like Southdale.
    - J. No, because it adds unnecessary details that detract from the description of Southdale.

69. Which choice most closely maintains the sentence pattern the writer has established in the previous two sentences?
    - A. NO CHANGE
    - B. Businesses were thrilled by the profits.
    - C. The profits thrilled businesses.
    - D. The profits were thrilling.

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Southdale Center's layout became so successful that
70
many of them soon sprang up in cities all over the
71
United States. [B]

[4]

Gruen, however, grew increasingly dismayed. [72] He had envisioned Southdale as one part of a larger planned community with houses, apartments, schools, and offices, but his community was never built. [C] The popularity of malls, while minimizing urban sprawl,
73
encouraged it; stores and paved parking areas multiplied in US cities and suburbs. [D] Disheartened, Gruen eventually returned to Vienna later on, only to find—just
74
south of the downtown he remembered so fondly—a mall.

70. **F.** NO CHANGE
G. very
H. more
J. DELETE the underlined portion.

71. **A.** NO CHANGE
B. copies of the mall
C. a large number
D. they

72. The writer is considering adding the following true statement:

> The Mall of America, a much larger mall in Minnesota, opened in 1992.

Should the writer make this addition here?

F. Yes, because it supports the claim that Gruen's design became popular.
G. Yes, because it compares Southdale to another well-known mall in Minnesota.
H. No, because it is only loosely related to the essay's discussion of Southdale.
J. No, because it shows that other malls changed architectural conventions more than Gruen's did.

73. **A.** NO CHANGE
B. instead of
C. despite
D. truly

74. **F.** NO CHANGE
G. to Vienna, where he had grown up,
H. back to Vienna again,
J. to Vienna,

Question 75 asks about the preceding passage as a whole.

75. The writer wants to add the following sentence to the essay:

> It was a mall.

The sentence would most logically be placed at:

A. Point A in Paragraph 2.
B. Point B in Paragraph 3.
C. Point C in Paragraph 4.
D. Point D in Paragraph 4.

END OF TEST 1

STOP! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO.

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MATHEMATICS TEST

60 Minutes—60 Questions

DIRECTIONS: Solve each problem, choose the correct answer, and then fill in the corresponding oval on your answer document.

Do not linger over problems that take too much time. Solve as many as you can; then return to the others in the time you have left for this test.

You are permitted to use a calculator on this test. You may use your calculator for any problems you choose, but some of the problems may best be done without using a calculator.

Note: Unless otherwise stated, all of the following should be assumed.

1. Illustrative figures are NOT necessarily drawn to scale.
2. Geometric figures lie in a plane.
3. The word *line* indicates a straight line.
4. The word *average* indicates arithmetic mean.

DO YOUR FIGURING HERE.

1. What is the greatest common factor of 60, 84, and 126 ?

   A. 12
   B. 6
   C. 3
   D. 2
   E. 1

2. $4n^7 \cdot 3n^5$ is equivalent to:

   F. $7n^2$
   G. $7n^{12}$
   H. $7n^{35}$
   J. $12n^{12}$
   K. $12n^{35}$

3. Devon bought running shoes at a price that was $\frac{1}{4}$ off the original price of \$88. He paid a sales tax of 7% on the discounted price and gave the clerk four \$20 bills. How much change should he receive?

   A. \$ 4.62
   B. \$ 7.84
   C. \$ 9.38
   D. \$12.46
   E. \$18.62

4. Brandon is having a bake sale at school to raise \$140.00 to donate to the local animal shelter. He sells brownies for \$1.00 each and cookies for \$0.50 each. Given that Brandon sells 82 brownies, and all sales go to the donation, how many cookies does he need to sell to reach his goal?

   F. 29
   G. 58
   H. 111
   J. 116
   K. 444

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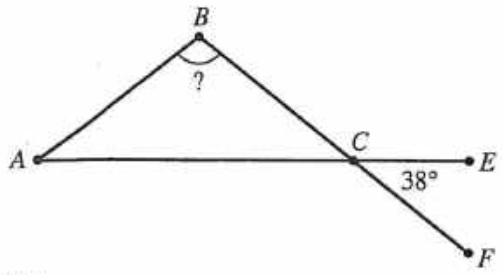
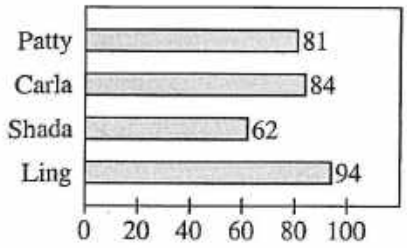
5. In the figure below, $\overline{AB}$ is congruent to $\overline{BC}$, and $\overline{AE}$ intersects $\overline{BF}$ at C. What is the measure of $\angle B$?



A. 14°
B. 38°
C. 76°
D. 104°
E. 142°

6. Patty, Carla, Shada, and Ling ran a race. The bar graph below gives each girl's running time, in seconds. How many of the girls ran the race in less time than the average of the 4 running times?



F. 0
G. 1
H. 2
J. 3
K. 4

7. Between 9:00 a.m. and 10:20 a.m., 18,000 visitors entered the Family Fun Amusement Park. Between 9:00 a.m. and 10:20 a.m., an average of how many visitors per minute entered the park?

A. 20
B. 25
C. 150
D. 225
E. 300

8. Given that $\mathbf{u}$ and $\mathbf{v}$ are vectors such that $\mathbf{u} = \langle -1, 3 \rangle$ and $\mathbf{v} = \langle 5, 8 \rangle$, what is the component form of the vector $\mathbf{u} + \mathbf{v}$?

F. $\langle 2, 13 \rangle$
G. $\langle 4, 5 \rangle$
H. $\langle 4, 11 \rangle$
J. $\langle 6, 5 \rangle$
K. $\langle 6, 11 \rangle$

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9. Juan and Xie are painting a room in the city recreation center. They started with 5 gallons of paint. On the first day, Juan used $\frac{1}{2}$ gallon of paint and Xie used $1\frac{3}{4}$ gallons of paint. How many gallons of paint were left after the first day?

   A. $2\frac{1}{4}$
   B. $2\frac{3}{4}$
   C. $3\frac{1}{4}$
   D. $3\frac{3}{4}$
   E. $4\frac{1}{2}$

10. The point $(4,r)$ lies on the graph of $y = -3x + 2$ in the standard (x,y) coordinate plane. What is the value of r?

   F. −4
   G. −10
   H. −14
   J. −18
   K. −24

11. Sebastian programs his calculator to evaluate a linear function, but he doesn't say what the function is. When 8 is entered, the calculator displays the value 6. When 12 is entered, the calculator displays the value 9. Which of the following expressions explains what the calculator will display when any number, n, is entered?

   A. $\frac{3}{4}n$
   B. $\frac{4}{3}n$
   C. $n - 2$
   D. $n - 3$
   E. $\frac{4}{3}n - \frac{14}{3}$

12. A function $f(x)$ is defined as $f(x) = -4x^2$. What is $f(-5)$?

   F. −400
   G. −100
   H. 80
   J. 100
   K. 400

13. When $x = -1$, what is the value of $4x^3 - 2x^2$?

   A. −8
   B. −6
   C. −2
   D. 2
   E. 6

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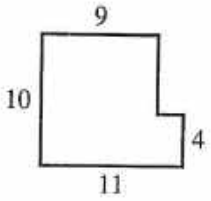
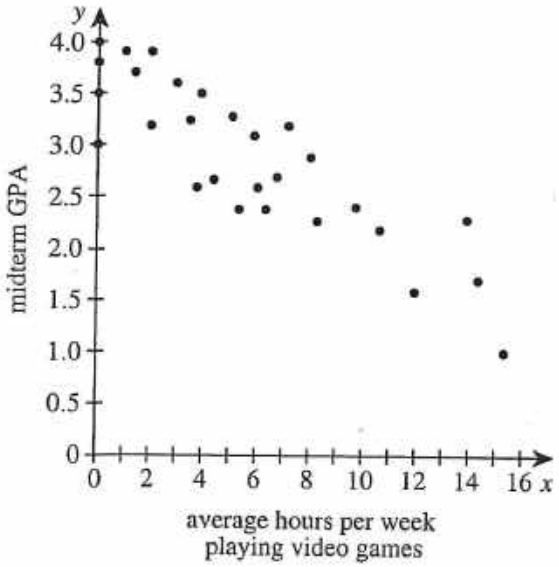
14. In the figure shown below, all angles are right angles, and the side lengths given are in yards. What is the area, in square yards, of the figure?

DO YOUR FIGURING HERE.

F. 12
G. 74
H. 98
J. 110
K. 134



15. A certain fraternity had its freshmen members keep a log of their hours spent playing video games. When midterm grades were known, the fraternity president plotted the data in the standard (x,y) coordinate plane with average hours per week spent playing video games on the x-axis and midterm grade point average (GPA) on the y-axis as shown in the figure below. He then performed a linear regression on the data. Which of the following statements is true of the regression equation?



A. The slope and the y-intercept are both negative.
B. The slope and the y-intercept are both positive.
C. The slope is negative, and the y-intercept is positive.
D. The slope is positive, and the y-intercept is negative.
E. The slope is 0, and the y-intercept is positive.

16. Given $4x + 2 = -10$, then $|5 - x^2| = ?$

F. 1
G. 4
H. 9
J. 11
K. 14

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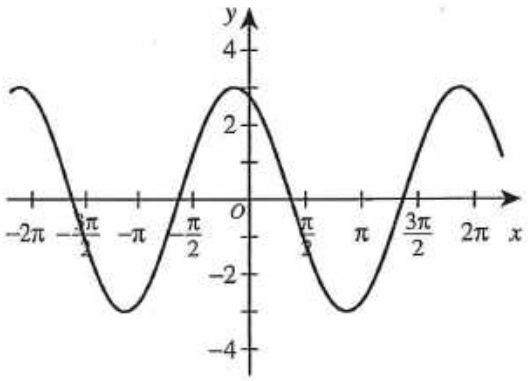
17. The graph of $y = 3\sin(x + 2)$ is shown in the standard (x,y) coordinate plane below. What is the maximum value of this function?



A. 2
B. 3
C. 6
D. π
E. 2π

18. Renata took 9 quizzes in German class. Her scores, in order, were 6, 7, 7, 6, 8, 7, 8, 10, and 9. She discovered a scoring error on the 9th quiz, and her score on that quiz was corrected to 10. Which of the following measures of central tendency changed as a result of the correction?

I. Mean
II. Median
III. Mode

F. I only
G. II only
H. I and II only
J. II and III only
K. I, II, and III

19. Which of the following equations is that of a line parallel to the line with equation $y = \frac{2}{3}x + 4$ in the standard (x,y) coordinate plane?

A. $y = -\frac{3}{2}x + 4$

B. $y = -\frac{3}{2}x + 7$

C. $y = -\frac{2}{3}x + 4$

D. $y = \frac{3}{2}x + 4$

E. $y = \frac{2}{3}x + 7$

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20. For $\triangle ABC$ shown below, what is the value of $\tan B$?

DO YOUR FIGURING HERE.

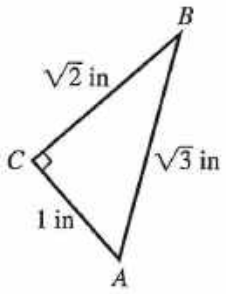
F. $\sqrt{2}$

G. $\sqrt{3}$

H. $\frac{1}{\sqrt{2}}$

J. $\frac{\sqrt{3}}{\sqrt{2}}$

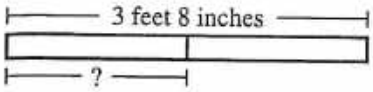
K. $\frac{1}{\sqrt{3}}$



21. Given the true statement "If I live in Chicago, then I live in Illinois," which of the following statements *must* be true?

A. I live in Illinois.
B. I live in Chicago.
C. If I live in Illinois, then I live in Chicago.
D. If I don't live in Chicago, then I don't live in Illinois.
E. If I don't live in Illinois, then I don't live in Chicago.

22. Shown below, a board 3 feet 8 inches long is cut into 2 equal parts. What is the length, to the nearest inch, of each part?



F. 1 foot 5 inches
G. 1 foot 8 inches
H. 1 foot 9 inches
J. 1 foot 10 inches
K. 2 feet 5 inches

23. What is the minimum number of square floor tiles, each 9 inches on a side, that could be used to cover the floor of a rectangular hallway 15 feet long and 6 feet wide?

A. 28
B. 56
C. 81
D. 90
E. 160

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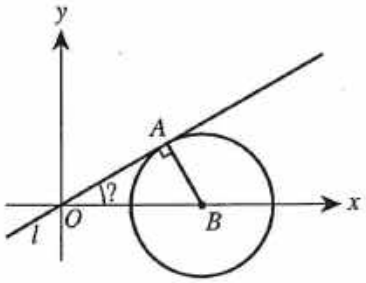
24. Graphed in the standard (x,y) coordinate plane below is line l and the circle with equation $(x-2)^2+y^2=1$. Line l passes through $O(0,0)$ and is tangent to the circle at A, and B is the center of the circle. What is the measure of $\angle AOB$?



F. 15°
G. 22.5°
H. 30°
J. 45°
K. 60°

25. One square has a side whose length is x centimeters, and a second square has a side whose length is $(x-2)$ centimeters. What expression below represents the sum of the areas of the 2 squares, in square centimeters?

A. $2x^2-2$
B. x^2-4
C. $2x^2+4x-4$
D. $2x^2+4x+4$
E. $2x^2-4x+4$

26. When graphed in the standard (x,y) coordinate plane, the line with equation $\frac{5}{2}x+\frac{3}{4}y=-\frac{1}{2}$ has a slope of:

F. $-\frac{3}{10}$
G. $-\frac{2}{3}$
H. $-\frac{10}{3}$
J. $-\frac{15}{8}$
K. $-\frac{5}{2}$

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Use the following information to answer questions 27–29.

Kojo has an Internet site where his classmates can sell items in online auctions. For each item, a student pays Kojo a listing fee, based on the item's starting price, and a selling fee calculated as a percent of the selling price, as shown in the tables below.

Starting price	Listing fee
\$ 0.01–\$ 4.99	\$0.25
\$ 5.00–\$19.99	\$0.50
\$20.00–\$49.99	\$1.00
\$50.00 and up	\$2.00

Selling price	Selling fee
\$ 0.01–\$49.99	5% of selling price
\$50.00 and up	3% of selling price

27. Lucie sold a jacket on Kojo's site. The starting price of the jacket was \$6.25, and its selling price was \$34.20. What is the sum of the listing fee and selling fee Lucie paid to sell the jacket?

A. \$1.50
B. \$1.71
C. \$2.02
D. \$2.21
E. \$2.52

28. For the items his classmates listed on his site last Friday, Kojo was paid listing fees that totaled \$5.75. What is the maximum number of the items listed last Friday whose starting prices could have been in the range of \$5.00–\$19.99 ?

F. 11
G. 12
H. 23
J. 39
K. 40

29. Erick sold 2 items on Kojo's site. The sum of the selling prices for the 2 items was \$116.00. The sum of the selling fees for the 2 items was \$4.34. The system of equations below can be used to obtain the selling price for each item. What was the total listing fee for the 2 items given that the starting price was equal to the selling price for each of the 2 items?

$$\begin{aligned} x + \quad y &= 116.00 \\ 0.03x + 0.05y &= \quad 4.34 \end{aligned}$$

A. \$2.00
B. \$2.25
C. \$2.50
D. \$3.00
E. \$4.00

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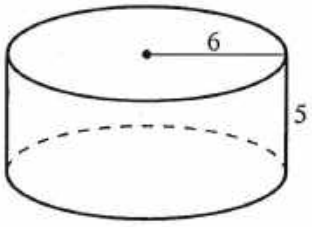
30. A formula for the volume, V, of a right circular cylinder is $V = \pi r^2 h$, where r is the radius and h is the height. The cylindrical tank shown below has radius 6 meters and height 5 meters and is filled with water.



Given that the weight of 1 cubic meter of water is approximately 2,205 pounds, the weight, in pounds, of the water in the tank is:

F. less than 400,000.
G. between 400,000 and 900,000.
H. between 900,000 and 1,200,000.
J. between 1,200,000 and 1,700,000.
K. more than 1,700,000.

31. Admission to a carnival is \$4 for children and \$6 for adults. A group of 21 people pays \$90 for admission to the carnival. What is the ratio of the number of children to the number of adults in this group?

A. 3:1
B. 4:1
C. 6:1
D. 9:1
E. 18:1

32. For all nonzero x, y, and z, which of the following is equal to $\left(\frac{2x^3y^{-5}z^8}{8x^{-2}y^6z^3}\right)^{-2}$?

F. $\frac{16x^{10}y^{22}}{z^{10}}$

G. $\frac{16y^{22}z^{10}}{x^{10}}$

H. $\frac{x^{10}y^{22}}{16z^{10}}$

J. $\frac{x^{10}z^{10}}{16y^{22}}$

K. $\frac{16y^{22}}{x^{10}z^{10}}$

33. The functions f and g are defined as $f(x) = 2x + 3$ and $g(x) = x^2 - 1$. What is $f(g(-1))$?

A. −1
B. 0
C. 1
D. 3
E. 5

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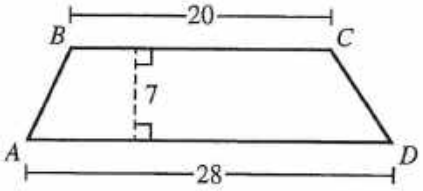
34. In a window display at a flower shop, there are 3 spots for 1 plant each. To fill these 3 spots, Adam has 7 plants to select from, each of a different type. Selecting from the 7 plants, Adam can make how many possible display arrangements with 1 plant in each spot?

(Note: The positions of the unselected plants do not matter.)

F. 3
G. 7
H. 18
J. 210
K. 343

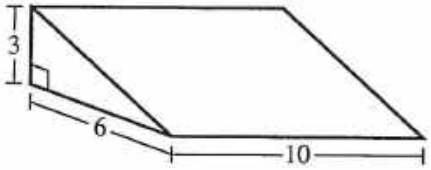
35. In quadrilateral $ABCD$ shown below, $\overline{BC} \parallel \overline{AD}$, $BC = 20$ inches, $AD = 28$ inches, and the distance between $\overline{BC}$ and $\overline{AD}$ is 7 inches. What is the area, in square inches, of quadrilateral $ABCD$?

A. 140
B. 168
C. 196
D. 336
E. 560



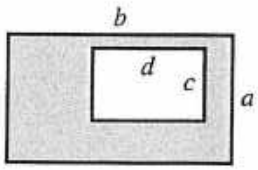
36. The figure below shows a solid concrete ramp for skateboarding. The length is 10 feet, the width is 6 feet, and the height is 3 feet. Which of the following values is closest to the volume, in cubic feet, of the concrete used to construct the ramp?

F. 32
G. 76
H. 90
J. 115
K. 180



37. A rectangle that is c inches by d inches is in the interior of a rectangle that is a inches by b inches, as shown below. The area of the shaded region is what fraction of the area of the large rectangle, in terms of a, b, c, and d?

A. $\frac{ab - cd}{ab}$
B. $\frac{ab + cd}{ab}$
C. $\frac{ab - cd}{cd}$
D. $\frac{ab + cd}{cd}$
E. $\frac{(a - c)(b - d)}{ab}$



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38. A company prints contest codes on its fun-size bags of candy. Each 6-character code consists of the letter A followed by the letter H followed by 4 of the digits 0 through 9. The digits may repeat. Which of the following expressions gives the number of different 6-character codes that are possible?

F. 1(1)(10)(10)(10)(10)
G. 2(1)(10)(9)(8)(7)
H. 2(1)(10)(10)(10)(10)
J. 2(2)(10)(9)(8)(7)
K. 2(2)(10)(10)(10)(10)

39. The mean of the daily high temperatures for a 5-day period in a certain city was recorded as being 4.0°F. It was later determined that the high temperature for 1 of these 5 days was recorded incorrectly. If that day's high temperature was 2°F higher than originally recorded, what is the difference between the incorrectly recorded mean and the correct mean?

A. 0.4°F
B. 1.2°F
C. 2.0°F
D. 4.0°F
E. 4.4°F

40. A box contains 6 objects. Of those, 3 are disks (2 blue and 1 red) and 3 are triangles (1 blue, 1 red, and 1 yellow). If the probability of drawing each object is the same, what is the probability that an object drawn from the box is a blue object or a triangle?

F. $\frac{1}{6}$
G. $\frac{1}{4}$
H. $\frac{1}{2}$
J. $\frac{2}{3}$
K. $\frac{5}{6}$

41. When $\log_4 x = -3$, what is x ?

A. $\frac{1}{64}$
B. $\frac{1}{12}$
C. -12
D. -64
E. There is no such value of x.

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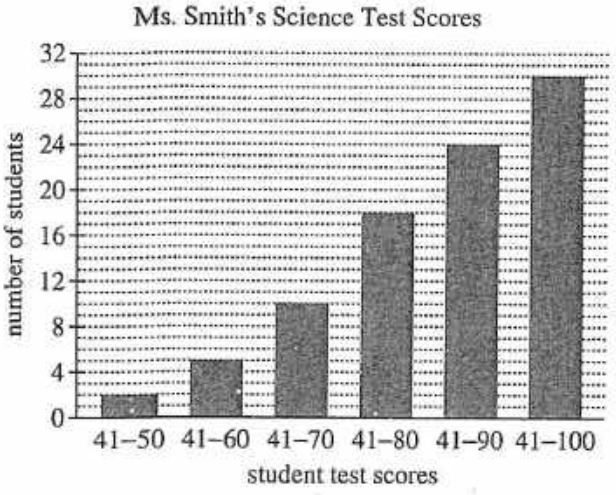
Use the following information to answer questions 42–44.

The whole number test scores of all 30 students in Ms. Smith's science class are represented in the cumulative frequency bar graph below.



42. How many students in Ms. Smith's science class had a score greater than 70 on the test?

F. 13
G. 17
H. 18
J. 20
K. 72

43. Which of the following intervals *must* contain the median score of the students' test scores in Ms. Smith's science class?

A. 56–65
B. 61–70
C. 66–75
D. 71–80
E. 76–85

44. The students in Mr. Cho's class took the same test as those in Ms. Smith's class. The number of students in Mr. Cho's class with a score in the range 41–50 was 3 less than 4 times the number of students in Ms. Smith's class with a score in the range 41–50. How many students in Mr. Cho's class had a score in the range 41–50 on this test?

F. 5
G. 4
H. 3
J. 2
K. 1

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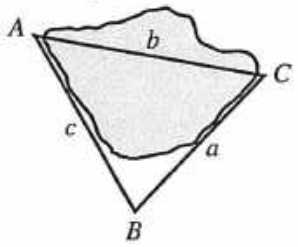
45. The solution set of the equation $|x-1| = x-1$ is the set of all values of x such that:

A. $x \leq 1$
B. $x \geq 1$
C. $x \leq 0$
D. $x \geq 0$
E. x is a real number.

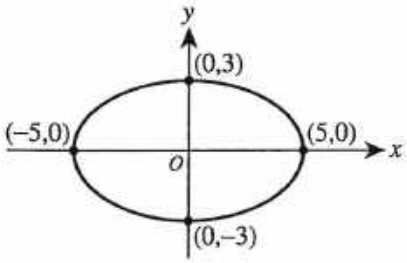
46. A surveyor needs to find the length from point A to point C across a lake as shown in the figure below. The measurements of which of the following angles and side lengths are sufficient for the surveyor to determine the length of $\overline{AC}$ using only the law of sines?



(Note: The law of sines says $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$.)

	angle	side length
F.	A, B	a
G.	A	c
H.	B	a, c
J.	B	c
K.	C	a

47. Which of the following equations determines the ellipse shown in the standard (x,y) coordinate plane below?



A. $3x^2 + 5y^2 = 15$
B. $6x^2 + 10y^2 = 60$
C. $9x^2 + 25y^2 = 225$
D. $36x^2 + 100y^2 = 3{,}600$
E. $\frac{x^2}{5} + \frac{y^2}{3} = 1$

48. Given that $x = -2$ is a solution to $x^2 + bx - 6 = 0$, which of the following polynomials is a factor of $x^2 + bx - 6$?

F. $x-3$
G. $x-2$
H. $x-1$
J. $x+1$
K. $x+3$

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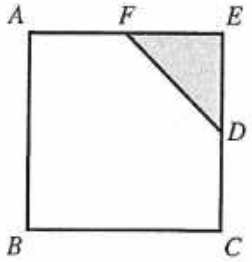
DO YOUR FIGURING HERE.

49. Square $ABCE$, shown below, has a side length of 10 inches. Point D is the midpoint of $\overline{CE}$, and F is the midpoint of $\overline{AE}$. What is the ratio of the area of $\triangle DEF$, shown shaded, to the area of pentagon $ABCDF$?



A. 1:3
B. 1:4
C. 1:7
D. 1:8
E. 1:10

50. For some positive integer k, the sum of the absolute values of all the integers from $-k$ through k is 12. What is the value of k?

F. 2
G. 3
H. 4
J. 6
K. Cannot be determined from the given information

51. Two real-valued functions are defined by $f(x) = \sqrt{x} + 1$ and $g(x) = (x - 3)^3$. What is the domain of $f(g(x))$?

A. $[0,\infty)$
B. $[1,\infty)$
C. $[3,\infty)$
D. $[4,\infty)$
E. $(-\infty,\infty)$

52. A highway engineer is using a road map to lay out a detour for the westbound lane of a section of highway that, on the map, is a straight line going east and west. On the map, the detour goes 4 miles straight north, 1 mile straight west, 2 miles straight north, 6 miles straight west, 3 miles straight south, 1 mile straight east, and finally 3 miles straight south, back to the highway. According to the map, how many more miles will a westbound driver travel by taking the detour than he would if he could stay on the highway?

F. 20
G. 14
H. 13
J. 12
K. 6

53. The solution to the equation $3d + 17 = 13$ is which of the types of numbers listed below?

I. Rational
II. Irrational
III. Positive
IV. Negative
V. Integer

A. I and III only
B. I and IV only
C. II and III only
D. II and IV only
E. I, III, and V only

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DO YOUR FIGURING HERE.

54. For all real values of x such that $-1 < x < 0$, which of the following expressions has the greatest value?

F. x

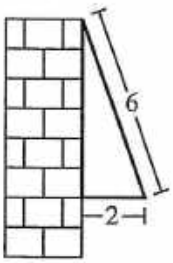
G. $2x$

H. $x+1$

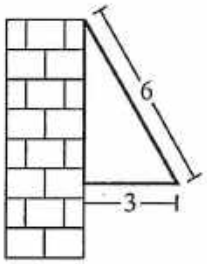
J. $\frac{1}{x}$

K. $-\frac{1}{x}$

55. A 6-foot awning that extended 2 feet horizontally from a vertical building at 8:00 a.m. was adjusted to extend 3 feet horizontally from the building at 12:00 p.m., as shown below. Which of the following expressions equals the positive difference in the measures of the angle between the awning and the building at 8:00 a.m. and at 12:00 p.m. ?



8:00 a.m.



12:00 p.m.

A. $\cos^{-1}\left(\frac{3-2}{6}\right)$

B. $\sin^{-1}\left(\frac{3-2}{6}\right)$

C. $\tan^{-1}\left(\frac{3-2}{6}\right)$

D. $\cos^{-1}\left(\frac{3}{6}\right) - \cos^{-1}\left(\frac{2}{6}\right)$

E. $\sin^{-1}\left(\frac{3}{6}\right) - \sin^{-1}\left(\frac{2}{6}\right)$

56. In the complex numbers, where $i^2 = -1$, $\frac{2-i}{-3+i} = ?$

F. $-\frac{2}{3} - i$

G. $-\frac{5}{8} + \frac{1}{8}i$

H. $-\frac{7}{8} + \frac{1}{8}i$

J. $-\frac{5}{10} + \frac{1}{10}i$

K. $-\frac{7}{10} + \frac{1}{10}i$

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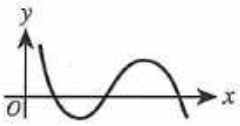
DO YOUR FIGURING HERE.

57. The degree measures of the interior angles of a certain pentagon are in the ratio 2:3:4:4:5. What is the measure of the largest interior angle of this pentagon?

A. 30°
B. 60°
C. 90°
D. 120°
E. 150°

58. The function $y = f(x)$ is graphed in the standard (x,y) coordinate plane below. The domain of f is the set of all positive real numbers. One of the following graphs is the graph of $y = -|f(x)|$. Which one is it?

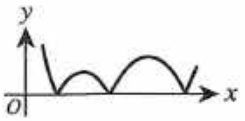


F.

J.

G.

K.

H.


59. The sale price of a jacket is 10% off the original price. The clearance price of the jacket is 30% off the sale price. The clearance price is what percent off the original price?

A. 20%
B. 27%
C. 33%
D. 37%
E. 40%

60. How long, in centimeters, is 1 side of a square whose perimeter is equal to the circumference of a circle with a radius of 2 centimeters?

F. π
G. $\frac{\pi}{2}$
H. 4π
J. 16π
K. 4

END OF TEST 2

STOP! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO.

DO NOT RETURN TO THE PREVIOUS TEST.

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READING TEST

35 Minutes—40 Questions

DIRECTIONS: There are several passages in this test. Each passage is accompanied by several questions. After reading a passage, choose the best answer to each question and fill in the corresponding oval on your answer document. You may refer to the passages as often as necessary.

Passage I

LITERARY NARRATIVE: This passage is adapted from the article "Trading Stories" by Jhumpa Lahiri (©2011 by Condé Nast).

Books, and the stories they contained, were the only things I felt I was able to possess as a child. Even then, the possession was not literal; my father is a librarian, and perhaps because he believed in collective property, I had almost no books to call my own.

Our house was not devoid of things to read, but the offerings felt scant. There were books about China and Russia. My mother owned novels and short stories and stacks of a literary magazine called *Desh*, but they were in Bengali. I craved a house where books were a solid presence, piled on every surface and cheerfully lining the walls.

What I really sought was a better-marked trail of my parents' intellectual lives: bound and printed evidence of what had inspired and shaped their minds. A connection, via books, between them and me. But my parents did not read to me or tell me stories; my father did not read any fiction, and the stories my mother may have loved as a young girl in Calcutta were not passed down.

Bengali was my first language, what I spoke and heard at home. But the books of my childhood were in English, and their subjects, for the most part, were either English or American lives. I was aware of a feeling of trespassing; I was aware that I did not belong to the worlds I was reading about: that different food graced our table, that different holidays were celebrated. And yet when a book was in my possession, this didn't matter.

As a young girl, I was afraid to participate in social activities. I was worried about what others might make of me. But when I read I was free of this worry. I learned what my fictional companions ate and wore, about the toys scattered in their rooms, the vacations they took, the jams their mothers stirred on the stove. For me, the act of reading was one of discovery in the most basic sense—the discovery of a culture that was foreign to my parents.

When I began to make friends, writing was the vehicle. I did not write alone but with another student in my class. We would sit together, dreaming up characters and plots, taking turns writing sections of the story. The stories were transparent riffs on what I was reading at the time: families living on prairies, orphaned girls sent off to boarding schools, children with supernatural powers.

As I grew into adolescence and beyond, however, my writing shrank. Though the compulsion to invent stories remained, self-doubt began to undermine it. What I loved at seven became, by seventeen, the form of self-expression that most intimidated me. At twenty-one, the writer in me was like a fly in the room—alive but insignificant, aimless, something that unsettled me whenever I grew aware of it.

After I graduated from college, I moved to Boston and formed a close friendship with a young woman whose father is a poet named Bill Corbett. I began to visit the Corbetts' home, which was filled with books and art. I saw the desk where Bill wrote, obscured by manuscripts, letters, and proofs. I saw that the work taking place on this desk was obliged to no one, connected to no institution; that this desk was an island. I spent a summer pecking out sketches and fragments on a typewriter.

I began to want to be a writer. Secretly at first, exchanging pages with one other person, our prescheduled meetings forcing me to sit down and produce something.

I worked up the nerve to apply for a formal spot in a creative-writing program. When I told my parents that I'd been accepted, with a fellowship, they neither encouraged nor discouraged me. Like so many aspects of my American life, the idea that one could get a degree in creative writing, that it could be a legitimate course of study, seemed perhaps frivolous to them.

As a child, I had written to connect with my peers. But when I started writing stories again, in my twenties, my parents were the people I was struggling to reach. In 1992, just before starting the writing program, I went to Calcutta with my family. I remember coming back at the end of summer and almost immediately writing the

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first of the stories I submitted that year in workshop. It was set in the building where my mother had grown up, and where I spent much of my time when I was in India. I see now that my impulse to write this story was to prove something to my parents: that I understood, in a limited but precise way, the world they came from.

For much of my life, I wanted to belong to a place, either the one my parents came from or to America. When I became a writer my desk became home; there was no need for another. I belong to my work, to my characters.

1. Which of the following events mentioned in the passage occurred last chronologically?
   - A. The author was accepted into a creative writing program.
   - B. The author moved to Boston.
   - C. The author visited the Corbetts' house.
   - D. The author went to Calcutta with her family.

2. Based on the passage, when the author read books about English and American lives, she enjoyed:
   - F. the stories even though she knew her parents didn't want her to read them.
   - G. learning about other cultures even though she felt like an intruder.
   - H. the books' plots, but she found the books' details to be distracting.
   - J. the characters, but she struggled to imagine their worlds.

3. The main function of the eighth paragraph (lines 55–64) is to:
   - A. outline the writing advice the author received from a Boston poet.
   - B. contrast the author's expectations of Boston with her experiences living there.
   - C. relate how a friendship influenced the author's commitment to writing.
   - D. describe a friend the author met while she was in college.

4. When the author says "the possession was not literal" (line 3), she most nearly means that she:
   - F. read at the library, but her father wouldn't let her borrow books.
   - G. had many books in her room, but they belonged to her parents.
   - H. read many books, but she owned very few of them.
   - J. heard stories from her mother, but she felt that the stories weren't hers.

5. Based on the passage, when the author was a child, reading books helped her by offering:
   - A. glimpses into the lives of children who lived in India.
   - B. a reprieve from her anxiety about her peers' opinions of her.
   - C. something to do while she waited for her parents to come home.
   - D. a way to learn the stories her mother loved as a child.

6. Based on the passage, the stories the author wrote as a child can best be described as:
   - F. updated versions of traditional Indian stories.
   - G. original tales about her school life.
   - H. slight variations on her father's stories.
   - J. obvious imitations of the books she was reading.

7. In the passage, the author states "this desk was an island" (line 62) primarily to support the idea that Corbett:
   - A. struggled with the isolation caused by his writing career.
   - B. composed his best poems in solitude.
   - C. wrote for himself, not out of obligation.
   - D. insisted on quiet when he was writing.

8. The passage most strongly suggests that the author believes her parents thought getting a degree in creative writing was a:
   - F. frivolous notion, though they didn't say so.
   - G. good opportunity, though they were unfamiliar with her program.
   - H. worthwhile pursuit, though they were unsure at first.
   - J. waste of time, though they encouraged her.

9. The author states that when she started writing stories again in her twenties, her motivation for writing had changed from trying to connect with her peers to trying to:
   - A. live up to her friends' expectations of her.
   - B. prove to herself that she could succeed.
   - C. make a connection with her parents.
   - D. escape from day-to-day life.

10. The main idea of the last paragraph is that the author:
    - F. writes about characters who search for a place to belong.
    - G. has grown accustomed to feeling out of place.
    - H. feels caught between India and America.
    - J. has found a sense of belonging in her writing.

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Passage II

SOCIAL SCIENCE: This passage is adapted from the book *Brave Companions: Portraits in History* by David McCullough (©1992 by David McCullough).

It was not long after the completion of the Panama Railroad in 1855 that Bedford Clapperton Pim declared with perfect composure that of all the world's wonders none could surpass this one as a demonstration of man's capacity to do great things against impossible odds.

"I have seen the greatest engineering works of the day," he wrote, ". . . but I must confess that when passing backwards and forwards on the Panama Railway, I have never been more struck than with the evidence, apparent on every side, of the wonderful skill, endurance, and perseverance, which must have been exercised in its construction."

Bedford Clapperton Pim was a British naval officer and of no particular historical significance. He had, however, seen a great deal of the world, he was a recognized authority on Central America, and his opinion was not lightly arrived at.

It should be kept in mind that the first railroads, all very primitive, had been built in Europe and the United States only some twenty years before. France was still virtually without railroads; not a rail had been put down west of the Mississippi as yet. Moreover, such awesome technological strides as the Suez Canal, the Union Pacific, and the Brooklyn Bridge were still well in the future. And so the vision of locomotives highballing through the green half-light of some distant rain forest, of the world's two greatest oceans joined by good English-made rails, could stir the blood to an exceptional degree.

The Panama Railroad was begun in 1850, at the height of the California gold craze. And by anyone's standards it was a stunning demonstration of man's "wonderful skill, endurance, and perseverance," just as Pim said, even though its full length was only forty-seven and a half miles. It was, for example, the first ocean-to-ocean railroad. Mile for mile it also appears to have cost more in dollars and in human life than any railroad ever built.

The surveys made by its builders produced important geographic revelations that had a direct bearing on the decision to build a Panama canal along the same route. In addition, the diplomatic agreement upon which the whole venture rested, the so-called Bidlack Treaty of 1846, was the basis of all subsequent involvement of the United States in Panama.

Still, the simple fact that it was built remains the overriding wonder, given the astonishing difficulties that had to be overcome and the means at hand in the 1850s. Present-day engineers who have had experience in jungle construction wonder how in the world it was ever managed. I think in particular of David S. Parker, an eminent army engineer whom I interviewed at the time he was governor of the Canal Zone. Through a great sweep of glass behind him, as we talked, were the distant hills of Panama, no different in appearance than they ever were. It is almost inconceivable, he said, that the railroad survey—just the survey—could have been made by a comparative handful of men who had no proper equipment for topographic reconnaissance (no helicopters, no recourse to aerial photography), no modern medicines, nor the least understanding of the causes of malaria or yellow fever. There was no such thing as an insect repellent, no bulldozers, no chain saws, no canned goods, not one reliable map.

A Panama railroad still crosses from the Atlantic to the Pacific, from Colón to Panama City. Much of the ride—especially if you are in one of the older cars (without air conditioning, windows open wide)—looks and feels as it must have originally. The full trip takes one hour and thirty minutes. But except for a few miles at either end, the present line is altogether different from the original. It takes a different route on higher ground. The old road has vanished beneath Gatun Lake, the enormous body of fresh water that comprises most of the canal and that can be seen close by on the right much of the way as you head toward the Pacific.

The original line was built as hurriedly and cheaply as circumstances would allow, to take advantage of the bonanza in California traffic. The route was always along the line of least resistance. Anything formidable in the way—a hill, a bend in the Chagres River—was bypassed if possible. No tunnels were attempted (there is one on the present line), and the winding right of way chopped through the jungle was just wide enough to let a train pass. Still, this one little stretch of track took nearly five years to build and cost $8 million, which averages out to a little less than ten miles a year and a then unheard-of $168,000 per mile.

11. The main purpose of the passage is to:

- **A.** explain why the completion of the original Panama Railroad is both puzzling and impressive.
- **B.** compare the construction challenges of the Panama Railroad with those of the Panama Canal.
- **C.** contrast features of the original Panama Railroad with those of the new line.
- **D.** provide a historical overview of the origins of the United States' involvement in Panama.

12. One reason the passage author points out the length of the Panama Railroad is to indicate:

- **F.** how close the Atlantic and Pacific Oceans are to each other in Panama.
- **G.** how expensive the railroad project was despite its short length.
- **H.** why the railroad survey took a relatively short amount of time to complete.
- **J.** why the tracks were built just wide enough to let a train pass.

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13. In the passage, the author characterizes the construction of the Panama Railroad as:

A. complex yet routine.
B. grueling yet brief.
C. incomplete and rushed.
D. costly and dangerous.

14. The main purpose of the second paragraph (lines 7–13) is to provide:

F. a firsthand account of the experience of helping build the original line of the Panama Railroad.
G. details about what the original line of the Panama Railroad looked like.
H. evidence to support the idea that Pim was knowledgeable about Central America.
J. an excerpt from Pim's writing that demonstrates his enthrallment with the Panama Railroad.

15. The main idea of the sixth paragraph (lines 40–46) is that the:

A. Bidlack Treaty was the catalyst for the Panama Railroad project.
B. Bidlack Treaty and surveys of the Panama Railroad project laid the foundation for the Panama Canal and future US involvement in Panama.
C. railroad surveyors made important discoveries about the geography of Panama, which informed other Central American railroad projects.
D. United States was involved in Panama for a brief period of time in the late nineteenth century.

16. The main purpose of the lists in lines 59–65 is to:

F. indicate the range of obstacles the builders of the Panama Railroad would have faced.
G. describe the kinds of tools the surveyors of the Panama Railroad would have used.
H. identify the steps involved in a typical railroad survey process at the time.
J. suggest the kinds of problems builders of the Panama Railroad reported to Parker.

17. The passage indicates that Pim's perspective on the Panama Railroad is authoritative partly because he:

A. was a British naval officer who was an expert on railroad construction.
B. was an important historical figure in Central America.
C. had traveled the world extensively and seen many feats of engineering.
D. had written reviews of many of the world's wonders.

18. As it is used in line 18, the word *lightly* most nearly means:

F. nimbly.
G. peacefully.
H. carelessly.
J. freely.

19. It can reasonably be inferred from the passage that the present line of the Panama Railroad was built on higher ground because the builders needed to:

A. create a more scenic route for tourists and travelers.
B. allow for the construction of the Panama Canal.
C. offer a more direct route from Colón to Panama City.
D. make it easier for the train cars to travel through the thick jungle.

20. Based on the passage, which of the following statements best describes a feature of the current Panama Railroad that did not exist when it was first constructed?

F. The railroad bypasses bends in the Chagres River.
G. The railroad travels through a tunnel.
H. The railroad connects the Atlantic and Pacific Oceans.
J. The railroad cars have windows that open wide.

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Passage III

HUMANITIES: Passage A is adapted from the essay "Henry D. Thoreau" by John Burroughs (©1882 by The Century Co.). Passage B is adapted from the essay "Qualified Homage to Thoreau" by Wallace Stegner (©1992 by the Estate of Wallace Stegner).

Passage A by John Burroughs

Thoreau's fame has steadily increased since his death, in 1862, as it was bound to do. It was little more than in the bud at that time, and its full leaf and flowering are not yet, perhaps not in many years yet. He improves with age; in fact, requires age to take off a little of his asperity and fully ripen him. The generation he lectured so sharply will not give the same heed to his words as will the next and the next. The first effect of the reading of his books, upon many minds, is irritation and disapproval; the perception of their beauty and wisdom comes later. He was a man devoid of compassion, devoid of sympathy, devoid of generosity, devoid of patriotism, as these words are usually understood, yet his life showed a devotion to principle such as one life in millions does not show; and matching this there runs through his works a vein of the purest and rarest poetry and the finest wisdom. For both these reasons time will enhance rather than lessen the value of his contributions. The world likes a good hater and refuser almost as well as it likes a good lover and acceptor, only it likes him farther off.

In writing of Thoreau, I am not conscious of having any criticism to make of him. I would fain accept him just as he was, and make the most of him, defining and discriminating him as I would a flower or a bird or any other product of nature—perhaps exaggerating some features the better to bring them out. I suppose there were greater men among his contemporaries, but I doubt if there were any more genuine and sincere, or more devoted to ideal ends. If he was not this, that, or the other great man, he was Thoreau, and he fills his own niche well, and has left a positive and distinct impression upon the literature of his country. He was, perhaps, a little too near his friend and master, Emerson, and brought too directly under his influence. But the contour of his moral nature was just as firm and resisting. He was no more a soft-shelled egg, to be dented by every straw in the nest, than was his distinguished neighbor.

Passage B by Wallace Stegner

Walden Woods is the 2,680-acre area outside of Boston, Massachusetts, that inspired Thoreau's book *Walden*.

Before I get around to saying why I think that Walden Woods absolutely must be preserved from subdivision and development, let me confess that, much as I admire Thoreau's hard-mouthed intellectual integrity and his knotty grappler's mind, I have some reservations about him. There are writings of his that I admire more than *Walden*—the essay "Walking," for example, which is superb from first line to last, and "Civil Disobedience," though this latter is as explosive as dynamite caps, and should not be left around where children might find it and play with it. Reading *Walden*, I am alternately exhilarated and exasperated, as some of the author's contemporaries were with the man himself. In one paragraph he may say something that has been waiting a thousand years to be said so well; in the next he is capable of something so outrageous that it sets my teeth on edge.

With the Thoreau who observed and participated in nature, the Thoreau who loved wildness, and the Thoreau who trusted physical labor so long as it was not a compulsion, and who mistrusted material ambition, I am completely in accord. It is Thoreau the moralizing enemy of the tradition to which he owes all his own authority who puts me off.

Like any zealot, he is intemperate. At times he sounds perilously like his spiritual descendants of the 1960s, who trusted no one over thirty and believed that they existed outside of, and were exempt from, the society they were protesting. What I miss in him, as I missed it in the more extreme rebels of the 1960s, is the acknowledgment that their society shaped them, that without it every individual of them would be a sort of Sasquatch, a solitary animal without language, thought, tradition, obligation, or commitment. It is culture, tradition, that teaches us to be human, teaches us almost everything, including how to protest and what to protest about.

I never hear Thoreau admitting this—in fact, he often specifically denies it, and his denials raise my temperature. "How about a little well-deserved humility?" I feel like asking him. It is like arguing with a television screen, but it eases the mind.

The fact is, it is precisely Thoreau's repudiation of the dead hand of the past that makes him so excruciatingly American. He pretends to believe that all experience is not merely fruitless, but damaging. "Men think they are wiser by experience, that is, by failure," he remarks in *Walden*. "I have always been regretting that I was not as wise as the day I was born."

Questions 21–23 ask about Passage A.

21. The main idea of the first paragraph of Passage A is that Thoreau's:

- **A.** lectures are still taught despite students' disapproval of the topics.
- **B.** most significant works of literature have been overshadowed by criticism of his personality.
- **C.** literature will continue to increase in value and relevance for future generations.
- **D.** literature is more appreciated than Emerson's literature is.

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22. Passage A states that although readers may not initially approve of Thoreau's books, they will ultimately appreciate Thoreau's writing for its:

F. sympathy and poetry.
G. patriotism and devotion.
H. generosity and compassion.
J. beauty and wisdom.

23. Based on Passage A, the passage author's only criticism of Thoreau is that:

A. Thoreau might have been too heavily influenced by Emerson.
B. Thoreau's literature focuses more on refusal than on acceptance.
C. Thoreau was less talented than his contemporaries were.
D. Thoreau was overly quick to judge those whose moral nature differed from his own.

Questions 24–27 ask about Passage B.

24. Which of the following statements best describes how the author of Passage B feels about Thoreau compared to how the author of Passage B feels about Walden Woods?

F. He rejects Thoreau's ideals and therefore does not see the value in preserving Walden Woods.
G. He embraces Thoreau's ideals but does not make clear his stance on the preservation of Walden Woods.
H. He believes that Thoreau's contemporaries were more talented and therefore does not think it's necessary to preserve Walden Woods.
J. He disagrees with some of Thoreau's ideals but still recognizes the value of preserving Walden Woods.

25. Based on Passage B, the passage author's main criticism of Thoreau is that Thoreau:

A. mistrusts material ambition.
B. is more interested in maintaining the status quo than in inciting change.
C. denies the influence that society has had on him as an individual.
D. writes about concepts that are inappropriate for a younger audience.

26. It can reasonably be inferred that the "dead hand of the past" (line 83) mainly refers to:

F. American cultural tradition.
G. Thoreau's *Walden*.
H. protestors in the 1960s.
J. the development of Walden Woods.

27. The author of Passage B compares Thoreau to a television screen most likely to indicate that arguing with Thoreau is:

A. entertaining.
B. futile.
C. unavoidable.
D. educational.

Questions 28–30 ask about both passages.

28. Compared to the author of Passage A, the author of Passage B provides more specific information about the:

F. opinion Thoreau's contemporaries had of his writing.
G. professional relationship Thoreau had with Emerson.
H. themes that Thoreau explored in his work.
J. reasons for Thoreau's increasing fame.

29. Compared to the assessment the author of Passage B makes about Thoreau's writing, the assessment the author of Passage A makes can best be described as more:

A. complimentary.
B. critical.
C. unbiased.
D. unenthusiastic.

30. Which of the following statements best captures the main difference in the purposes of the two passages?

F. Passage A predicts Thoreau's legacy as a writer while Passage B evaluates the soundness of some of Thoreau's ideals.
G. Passage A provides an example of one literary critic's opinion of Thoreau while Passage B provides examples of several critics' opinions.
H. Passage A questions Thoreau's literary clout while Passage B explains why Thoreau is an exceptional American writer.
J. Passage A compares Thoreau to a product of nature while Passage B compares Thoreau to a 1960s-era protester.

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Passage IV

NATURAL SCIENCE: This passage is adapted from the article "Molecular Evolution" by Tina Hesman Saey (©2009 by Society for Science & the Public).

Richard Lenski, an evolutionary biologist, is among the scientists hitting the rewind button on evolution. Meter-high letters taped to the window of his lab spell out the lab's motto: EVOLVE.

Inside the lab, a dozen glass flasks containing clear liquid swirl in a temperature-controlled incubator. Although the naked eye can't see them, millions of *E. coli* bacteria grow in the flasks, doing what the window exhorts. Lenski started the cultures in 1988, intending to follow the course of natural selection for several hundred generations. Now, two decades later, the cultures are still growing and have produced more than 45,000 generations of bacteria each.

These 12 flasks "represent the stripped-down bare essentials of evolution," says Zachary Blount, a graduate student in Lenski's lab. The environment never changes. No new genes enter the system from migrating microorganisms. And the scientists take no action to affect the course of evolution within the flasks. Only the intrinsic, core processes of evolution influence the outcome, Blount says.

Lenski and his colleagues have watched the game play out, occasionally analyzing DNA to peer over the players' shoulders and find out what cards they hold. On the surface, the populations in the 12 flasks seem to have traveled similar paths—all now grow larger cells and have become more efficient at using glucose than their ancestors. And many of the strains have accumulated mutations in the same genes. Notably, though, none of the strains developed exactly the same genetic changes.

Randomness is an important part of the evolutionary equation, as the experiment illustrates. During the first 2,000 generations, all of the 12 populations rapidly increased in size and fitness. But then these changes began to slow down, hitting the evolutionary equivalent of a dieter's plateau.

After 10,000 generations, it became apparent that not all the flasks were on the same trajectory. Though cells in all the flasks became larger, each population differed in the maximum size the cells reached. The populations also differed in how much fitter they were than their ancestors, when grown in direct competition. Several of the flasks now contain mutator strains, bacteria that have defects in their DNA replication system. Such defects make mistakes more likely to happen every time those bacterial strains copy their DNA to divide. Sometimes a mistake can have lethal consequences, damaging a gene crucial for survival. But other times coloring a bit outside the lines creates opportunity for advancement.

Even within a given flask, some bacteria take slightly different paths. One flask now contains two separate strains—one that makes large colonies when grown on petri dishes, and one that makes small colonies. The large- and small-colony strains have coexisted for more than 12,000 generations. The large-colony producers are much better at using glucose so they grow quickly, but they make by-products that the small-colony producers can eat. Both strains have increased in fitness over the generations.

Still, though the details were different, replaying evolution in a dozen flasks produced very similar outcomes in each.

But then something completely unexpected happened. After about 31,500 generations, glucose-eating bacteria in one flask suddenly developed the ability to eat a chemical called citrate, something no other *E. coli* do.

The switch was clearly a radical change of destination for the bacteria. The inability to eat citrate is a biochemical hallmark of the *E. coli* species, so by some definitions, the citrate eaters in that flask are no longer *E. coli*.

But a single change did not a citrate eater make. The researchers found that the bacteria went through a series of steps before evolving the ability to use citrate. One initial mutation happened at least 11,000 generations before the citrate eaters appeared. Lenski doesn't yet know which specific DNA changes led to citrate use, but it's clear that the ability to use citrate is contingent upon those earlier changes. And even bacteria that have undergone those initial changes are still not guaranteed to eat citrate. Blount tested 40 trillion bacteria from earlier generations to see if any could evolve the ability to eat citrate. Fewer than one in a trillion could.

The profound difference between the citrate eaters and the other 11 strains, as well as the dependence of the citrate change on earlier mutations, seems to suggest that replaying evolution will result in some surprise endings.

31. Based on the passage, which of the following statements best describes the evolution of bacteria populations in the flasks?

- **A.** Although most populations exhibited few evolutionary changes, one underwent a striking transformation within the first 100 generations.
- **B.** Although most populations followed the same evolutionary path, one produced bacteria that consumed glucose.
- **C.** Although the populations evolved differently at first, the populations became increasingly similar after 2,000 generations.
- **D.** Although not all of the populations followed the same evolutionary path, the outcomes were all similar up to about 31,500 generations.

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32. The passage indicates that the differences that have developed between the flask populations are in part a result of:

F. temperature changes occurring within each flask.
G. random mutations occurring within each flask.
H. variations in the number of bacteria initially placed in each flask.
J. variations in the age of the populations initially placed in each flask.

33. When the author states the bacteria in the flasks are "doing what the window exhorts" (lines 8–9), she most nearly means the bacteria are:

A. moving.
B. evolving.
C. swirling.
D. growing.

34. Based on the passage, Blount claims that the flasks "represent the stripped-down bare essentials of evolution" (lines 14–15) due to which of the following conditions?

I. The bacteria in the flasks are maintained in a consistent, closed environment.
II. No genes from migrating microorganisms enter the flasks.
III. Scientists refrain from actions that affect the course of evolution in the flasks.

F. I only
G. II only
H. III only
J. I, II, and III

35. The main purpose of the seventh paragraph (lines 52–61) is to:

A. contrast the age of small-colony strains of bacteria with that of large-colony strains.
B. compare conclusions reached by Lenski's experiment to those reached by similar experiments.
C. offer an example of how bacterial strains grown within a single flask can differ.
D. suggest several conclusions scientists could draw by comparing the colonies within a given flask.

36. The passage suggests that some strains of bacteria produce larger colonies than do others because the larger-colony strains:

F. use glucose more effectively.
G. eat the by-products of other colonies.
H. have fewer mutator genes in their DNA.
J. have coexisted with other strains for generations.

37. Based on the passage, what was the most surprising development observed during Lenski's experiment?

A. Citrate eaters outnumbered the other eleven strains of bacteria after just two generations.
B. Bacteria in one flask divided into two separate strains.
C. Bacteria in one flask developed into a new species of citrate eaters.
D. Both large- and small-colony bacteria strains increased in fitness over 12,000 generations.

38. According to the passage, after 10,000 generations, one indication that bacteria were developing differently in different flasks was that:

F. cells in each flask reached a different maximum size.
G. there were more cells in some flasks than in others.
H. some flasks produced new generations more quickly than did other flasks.
J. cells in some flasks began to die off at a quicker rate.

39. According to the passage, by some definitions, one characteristic of the *E. coli* species is its inability to:

A. eat citrate.
B. consume glucose.
C. coexist with other types of bacteria.
D. duplicate its DNA.

40. As it is used in line 87, the word *profound* most nearly means:

F. perceptive.
G. extreme.
H. heartfelt.
J. difficult.

END OF TEST 3

STOP! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO.

DO NOT RETURN TO A PREVIOUS TEST.

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SCIENCE TEST

35 Minutes—40 Questions

DIRECTIONS: There are several passages in this test. Each passage is followed by several questions. After reading a passage, choose the best answer to each question and fill in the corresponding oval on your answer document. You may refer to the passages as often as necessary.

You are NOT permitted to use a calculator on this test.

Passage I

Torrent frogs (*Staurois guttatus*) can cling to wet surfaces, even when the surfaces are at an angle of 90° (vertical) or greater. Researchers conducted 2 experiments to study how surface texture and water flow over the surface affects the clinging ability of *S. guttatus*.

Experiment 1

An apparatus was constructed with a transparent platform that could have different surface textures applied to it and that could be rotated 180°. A pump could direct water from a tank to flow over the platform (see Figure 1).

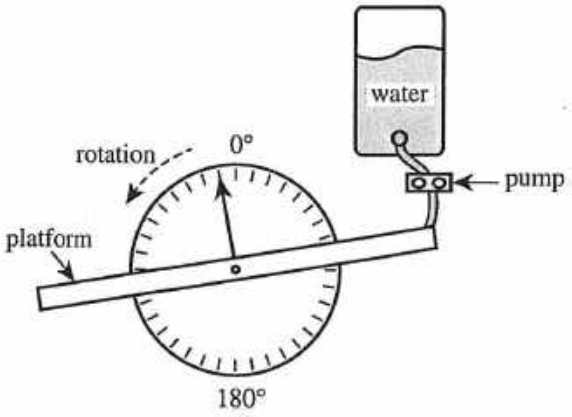

Figure 1

Then, in each of 9 trials (Trials 1–9), each of 10 *S. guttatus* (identical in size) was tested as follows:

1. The water flow rate was adjusted, a surface texture was applied to the platform, and the platform was rotated to a 10° angle.
2. A frog was placed on the platform.
3. The platform was rotated from 10° to 180° at a rate of 5° per sec.
4. The *angle of detachment* (angle at which the frog detached from the platform) was recorded.

The average angle of detachment was determined for each trial (see Table 1).

Table 1

Trial	Flow rate (L/min)	Surface texture	Average angle of detachment
1	0.0	smooth	180°
2	0.0	fine rough	136°
3	0.0	coarse rough	109°
4	1.0	smooth	165°
5	1.0	fine rough	150°
6	1.0	coarse rough	136°
7	4.0	smooth	155°
8	4.0	fine rough	125°
9	4.0	coarse rough	146°

Experiment 2

Trial 1 of Experiment 1 was repeated, but with a camera attached to the underside of the platform. At specific platform rotation angles during the trial, the camera was used to determine each frog's *contact area* (the surface area of the frog that was in contact with the platform), in millimeters squared (mm^2). The average contact area was determined for each angle (see Figure 2).

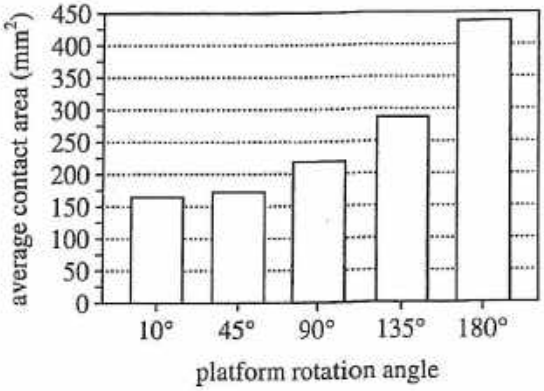

Figure 2

Table and figures adapted from T. Endlein et al., "Sticking Under Wet Conditions: The Remarkable Attachment Abilities of the Torrent Frog, *Staurois guttatus*." ©2013 by T. Endlein et al.

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1. According to the results of Experiment 2, as the platform rotation angle was increased, the average contact area:

   A. increased only.
   B. decreased only.
   C. increased and then decreased.
   D. decreased and then increased.

2. In Experiment 1, how many trials, in total, resulted in an average angle of detachment of 130° or less?

   F. 2
   G. 4
   H. 6
   J. 9

3. According to the results of Experiment 1, which of the following combinations of flow rate and platform texture resulted in an average angle of detachment of 150° ?

	flow rate (L/min)	platform texture
A.	1.0	smooth
B.	4.0	smooth
C.	1.0	fine rough
D.	4.0	fine rough

4. In Experiment 1, how long did it take the platform to rotate from 10° to 180° ?

   F. 13 sec
   G. 26 sec
   H. 34 sec
   J. 48 sec

5. Upon completion of the experiments, how many trials involving a smooth surface texture had been performed?

   A. 1
   B. 4
   C. 9
   D. 10

6. If a platform rotation angle of 150° had been tested in Experiment 2, the average contact area would most likely have been:

   F. less than 170 mm^2.
   G. between 170 mm^2 and 220 mm^2.
   H. between 220 mm^2 and 265 mm^2.
   J. greater than 265 mm^2.

7. Based on the results of Experiment 1, for a flow rate of 4.0 L/min, what is the order of platform texture, from the texture that resulted in the smallest average angle of detachment to the texture that resulted in the largest average angle of detachment?

   A. Smooth, fine rough, coarse rough
   B. Smooth, coarse rough, fine rough
   C. Fine rough, smooth, coarse rough
   D. Fine rough, coarse rough, smooth

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Passage II

In aqueous solutions, vitamin C ($C_6H_8O_6$) reacts with iodine (I_2) according to the balanced chemical equation

$$C_6H_8O_6 + I_2 \rightarrow C_6H_6O_6 + 2HI$$

The amount of vitamin C in a solution can be determined by performing a *titration*. The *titrant* (a solution containing a known concentration of I_2) is slowly added to the *analyte* (a solution containing a particular concentration of vitamin C), and a chemical reaction occurs. This process is monitored by adding an *indicator* to the analyte. The indicator is a colorless starch solution that changes to a dark color by reacting with I_2 when no more vitamin C remains, signaling the end of the titration.

Students performed titrations to determine the amount of vitamin C in 4 different types of pulp-free juice.

Experiment 1

A 0.20 mg/mL vitamin C solution was prepared. A 1.0 mL sample of the solution was placed into a vial, and 1 drop of indicator was added to the vial. Drops of the I_2 solution were then added to the vial until the indicator changed to a dark color. The procedure was repeated for solutions of 0.40, 0.60, 0.80, and 1.0 mg/mL of vitamin C (see Figure 1).

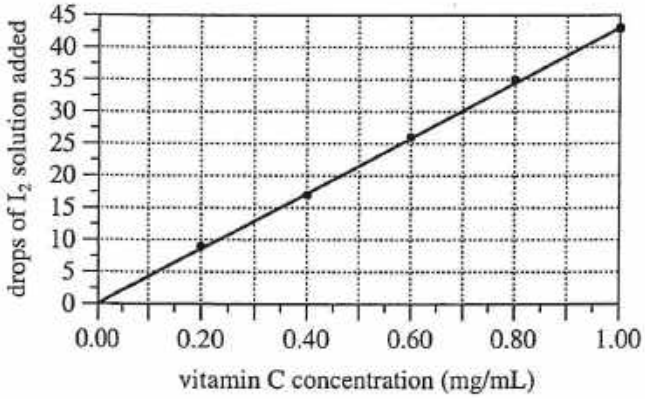

Figure 1

Experiment 2

A 1.0 mL sample of lime juice was placed into a vial, and 1 drop of indicator was added to the vial. Drops of the I_2 solution were added to the vial until the lime juice solution changed to a dark color. This procedure was repeated for 3 other juices (see Table 1).

Table 1

Juice	Drops of I_2 solution added
Lime	13
Grapefruit	17
Lemon	18
Orange	22

Figure and table adapted from R. Ballentine, "Determination of Ascorbic Acid in Citrus Fruit Juices." ©1941 by the American Chemical Society.

8. Consider the steps performed in Experiment 2 that are listed below.

   1. Stop adding titrant when the indicator changes to a dark color.
   2. Add starch indicator to vial.
   3. Place juice sample into vial.
   4. Slowly add drops of titrant.

   These steps were performed in what sequence?

   F. 3, 2, 1, 4
   G. 3, 2, 4, 1
   H. 2, 4, 1, 3
   J. 2, 4, 3, 1

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9. Based on the results of Experiments 1 and 2, which of the juices that were tested contained the greatest concentration of vitamin C ?

   A. Lime
   B. Grapefruit
   C. Lemon
   D. Orange

10. Suppose that the titration of a particular vitamin C solution requires 31 drops of the I_2 solution used in Experiment 1 to cause the indicator to change color. Based on the results of Experiment 1, the vitamin C solution has an approximate concentration of:

    F. 0.30 mg/mL.
    G. 0.50 mg/mL.
    H. 0.70 mg/mL.
    J. 0.90 mg/mL.

11. Based on the results of Experiments 1 and 2, the concentration of vitamin C in the lemon juice was closest to which of the following?

    A. 0.10 mg/mL
    B. 0.30 mg/mL
    C. 0.45 mg/mL
    D. 0.55 mg/mL

12. Suppose that a sample of apple juice had been titrated in Experiment 2 and the concentration of vitamin C in the apple juice was determined to be 0.10 mg/mL. Based on the results of Experiment 1, what is the *minimum* number of drops of the I_2 solution that would have been required to change the indicator in the apple juice solution to a dark color?

    F. 4
    G. 13
    H. 26
    J. 38

13. Based on the chemical equation in the passage, when vitamin C reacted with I_2 in the experiments, vitamin C:

    A. lost oxygen atoms.
    B. lost hydrogen atoms.
    C. gained oxygen atoms.
    D. gained hydrogen atoms.

14. Based on the results of Experiment 1, what approximate mass of vitamin C in a 1.0 mL sample reacted with each drop of the I_2 solution?

    F. 0.02 mg
    G. 0.05 mg
    H. 0.08 mg
    J. 0.10 mg

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Passage III

All known *exoplanets* (planets in orbit about stars other than the Sun) are too distant from Earth to be studied in detail, so mathematical models have been developed to help predict their properties. Figures 1–3 each show how a different property varies with altitude above the surface of Earth and above the surfaces of 2 hypothetical exoplanets: Planet X and Planet Y. Figure 1 shows how atmospheric temperature, T (in kelvins, K), varies; Figure 2 shows how atmospheric pressure, P (in atmospheres, atm), varies; and Figure 3 shows how gravitational field strength, g (in newtons per kilogram, N/kg), varies.

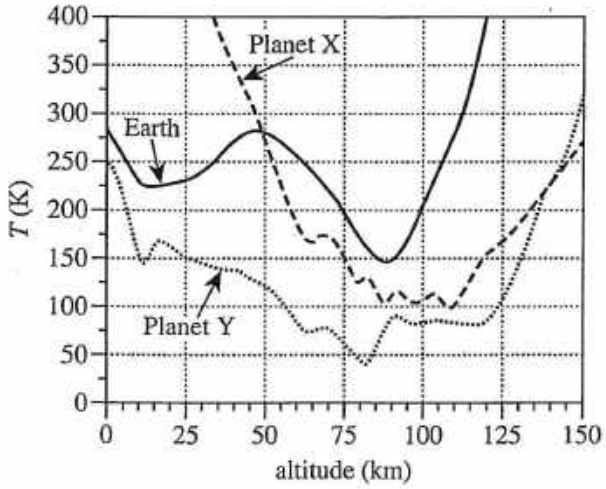

Figure 1

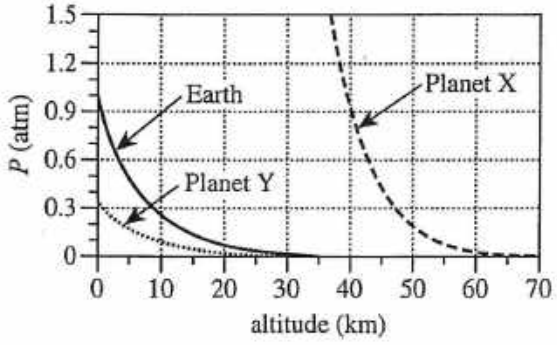

Figure 2

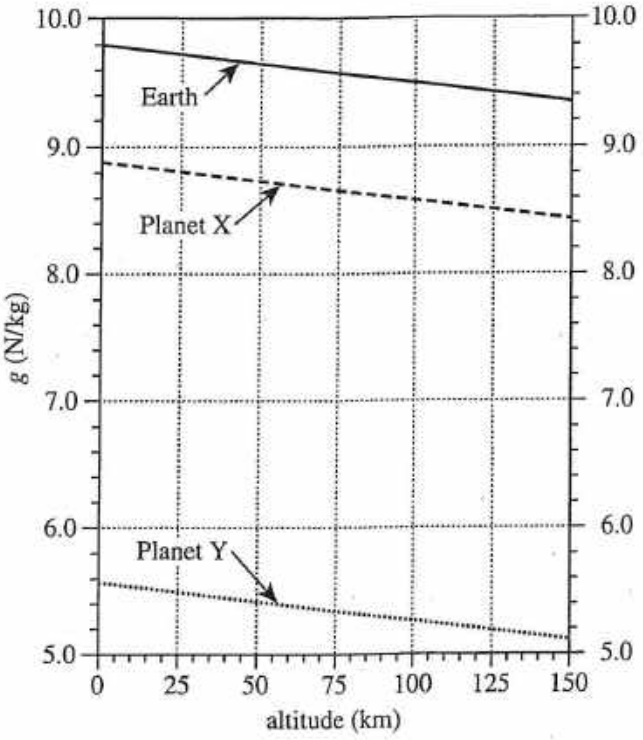

Figure 3

15. According to Figure 1, at approximately what altitude above their respective surfaces do Planets X and Y have the same atmospheric temperature, and what is that temperature?

	altitude (km)	temperature (K)
A.	50	225
B.	50	275
C.	140	225
D.	140	275

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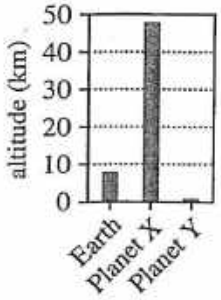
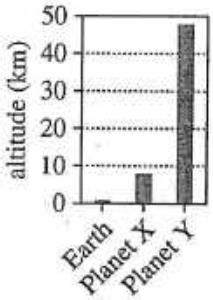
16. According to Figure 2, which of the following graphs best represents the altitude above the surface of Earth, of Planet X, and of Planet Y at which $P = 0.3$ atm ?

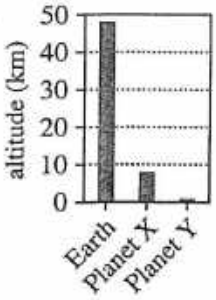
F.



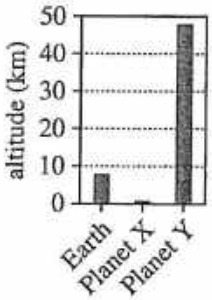
H.



G.



J.



17. Atmospheric *density* and P are directly proportional to each other. Based on Figure 2, which planet more likely has the more dense atmosphere at an altitude of 5 km, Earth or Planet Y ?

- **A.** Earth; at an altitude of 5 km, P for Earth is less than P for Planet Y.
- **B.** Earth; at an altitude of 5 km, P for Earth is greater than P for Planet Y.
- **C.** Planet Y; at an altitude of 5 km, P for Planet Y is less than P for Earth.
- **D.** Planet Y; at an altitude of 5 km, P for Planet Y is greater than P for Earth.

18. At the surface of a planet, g is given by the equation

$$g = \frac{GM}{R^2}$$

where G is a constant, M is the planet's mass, and R is the planet's radius. Assume that Earth, Planet X, and Planet Y have equal radii. Based on Figure 3, which planet has the greatest mass?

- **F.** Earth
- **G.** Planet X
- **H.** Planet Y
- **J.** Cannot be determined from the given information

19. Based on Figure 1, is the average kinetic energy of the gas particles in Earth's atmosphere more likely greater at an altitude of 40 km or 80 km ?

- **A.** 40 km, because the average kinetic energy of gas particles is directly proportional to gas temperature.
- **B.** 40 km, because the average kinetic energy of gas particles is inversely proportional to gas temperature.
- **C.** 80 km, because the average kinetic energy of gas particles is directly proportional to gas temperature.
- **D.** 80 km, because the average kinetic energy of gas particles is inversely proportional to gas temperature.

20. The gravitational field strength at the surface of Planet X is approximately what percent of the gravitational field strength at the surface of Earth?

- **F.** 60%
- **G.** 70%
- **H.** 80%
- **J.** 90%

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Passage IV

As sound waves travel through seawater, some of their energy is absorbed by the seawater. This *sound absorption* depends on several factors, including the pH of the water, the depth below the water's surface at which the sound waves travel, the frequency of the sound waves, the water temperature, and the water's *salinity* (concentration of dissolved salts in the water). Figures 1, 2, and 3 show—under the given conditions, respectively—how sound absorption (in decibels per kilometer, dB/km) varies with frequency (in kilohertz, kHz), temperature (in °C), and salinity (in parts per thousand, ppt; 1 ppt = 1 g/kg).

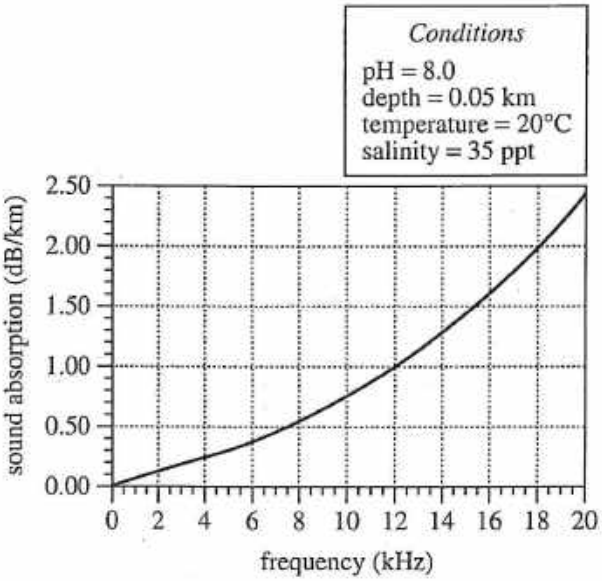

Figure 1

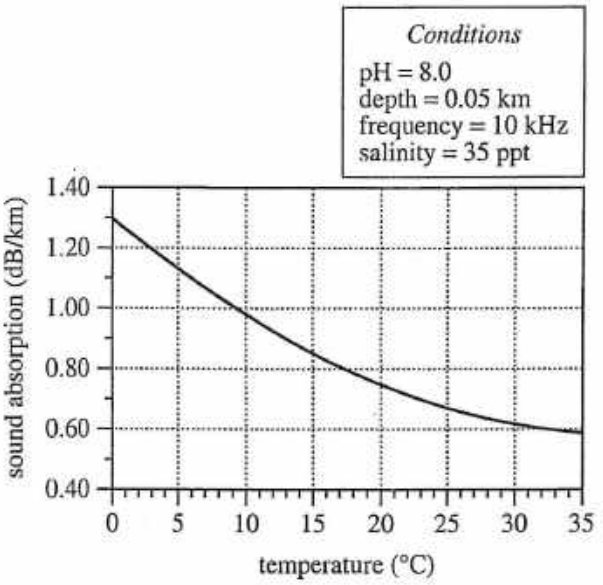

Figure 2

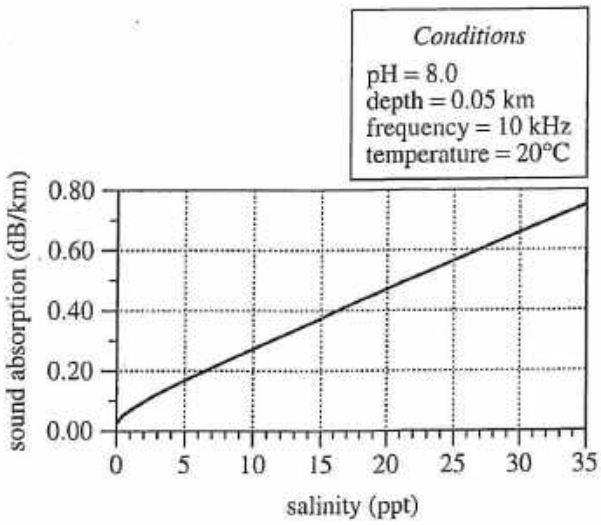

Figure 3

Figures adapted from Michael A. Ainslie and James G. McColm, "A Simplified Formula for Viscous and Chemical Absorption in Sea Water." ©1998 by Acoustical Society of America.

21. According to Figure 2, at which of the following water temperatures is the sound absorption by the seawater closest to 0.67 dB/km ?

A. 10°C
B. 15°C
C. 20°C
D. 25°C

22. Based on Figure 1, the sound absorption at a frequency of 18 kHz is about how many times as great as the sound absorption at a frequency of 12 kHz ?

F. $\frac{1}{3}$
G. $\frac{1}{2}$
H. 2
J. 3

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23. Suppose that, under the conditions given in Figure 3, sound waves travel a distance of 1 km from a source to a detector. Based on Figure 3, the *least* energy would be absorbed from the sound waves by the seawater if it has which of the following salinities?

A. 5 ppt
B. 15 ppt
C. 25 ppt
D. 35 ppt

24. Suppose sound absorption by seawater is measured under the conditions given in Figure 2, except that the frequency of the sound waves is 16 kHz. Based on Figures 1 and 2, if the temperature of the seawater is 3°C, will the sound absorption more likely be less than 1.20 dB/km or greater than 1.20 dB/km ?

F. Less than 1.20 dB/km, because sound absorption decreases as frequency decreases.
G. Less than 1.20 dB/km, because sound absorption decreases as frequency increases.
H. Greater than 1.20 dB/km, because sound absorption increases as frequency decreases.
J. Greater than 1.20 dB/km, because sound absorption increases as frequency increases.

25. As the acidity of seawater increases, sound absorption decreases. Based on Figure 2, at a depth of 0.05 km, a salinity of 35 ppt, a frequency of 10 kHz, a water temperature of 20°C, and a pH of 6.0, is the sound absorption less than 0.75 dB/km or greater than 0.75 dB/km ?

A. Less than 0.75 dB/km, because seawater at pH = 6.0 is less acidic than seawater at pH = 8.0.
B. Less than 0.75 dB/km, because seawater at pH = 6.0 is more acidic than seawater at pH = 8.0.
C. Greater than 0.75 dB/km, because seawater at pH = 6.0 is less acidic than seawater at pH = 8.0.
D. Greater than 0.75 dB/km, because seawater at pH = 6.0 is more acidic than seawater at pH = 8.0.

26. Consider in Figure 1 how sound absorption changes as the frequency of the sound waves increases. As the *wavelength* (NOT frequency) of the sound waves increases, does sound absorption increase or decrease?

F. Increase; as frequency increases, wavelength increases.
G. Increase; as frequency increases, wavelength decreases.
H. Decrease; as frequency increases, wavelength increases.
J. Decrease; as frequency increases, wavelength decreases.

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Passage V

Giant puffball mushrooms (GPMs) have belowground and aboveground structures. Belowground, tubelike threads called *hyphae* extend throughout the soil. Aboveground, the visible portion of the GPM is referred to as a *basidiocarp*. When some GPMs are disrupted, such as when they are stepped on by an animal, a cloud of particles resembling smoke is released from the basidiocarp. Two students discuss the function of the hyphae and basidiocarps in GPMs and also discuss the contents of the cloud of particles released when the basidiocarp is disrupted.

Student 1

The basidiocarps of GPMs are reproductive structures. When cells in the basidiocarp are mature, they produce, by meiosis, cells called *spores*. The spores are stored directly below the surface of the basidiocarp until the basidiocarp is disrupted. After release, a spore may settle in the soil, germinate, and then form a new hypha. When a newly formed hypha meets another newly formed hypha, they fuse and then produce a new basidiocarp. Young basidiocarps do not yet contain spores and thus do not produce a cloud of particles when disrupted.

The hyphae of a GPM acquire nutrients for the organism from organic matter in the soil. The nutrients are then transported to feed the aboveground structure.

Student 2

The hyphae of GPMs are reproductive structures, similar to the roots of some plants that reproduce asexually. To produce a new GPM, the hyphae grow away from the parental GPM to another location in the soil. Once the hyphae have grown away from the parental GPM, the hyphae produce a new basidiocarp. After the new basidiocarp has formed, the newly grown hyphae separate from the parental hyphae.

Like the leaves of plants, the basidiocarps of GPMs produce energy for the organisms through the process of photosynthesis. Basidiocarps also function as deterrents to predators by releasing a cloud of particles containing toxins when disrupted. Young GPMs do not yet produce toxins and are thus unable to release a cloud of particles.

27. According to Student 1 and Student 2, respectively, what is the main functional component contained in the cloud of particles from a disrupted basidiocarp?

	Student 1	Student 2
A.	spores	carbohydrates
B.	spores	toxins
C.	toxins	carbohydrates
D.	toxins	spores

28. Student 1 implies that the basidiocarps of some GPMs do *not* release a cloud of particles when disrupted because the:

F. cells of the basidiocarp have not yet made toxins.
G. cells of the basidiocarp have not yet become reproductively mature.
H. basidiocarp has not yet separated from the parental GPM.
J. basidiocarp has not yet produced enough energy for the GPM.

29. Student 2 indicates that the hyphae of a GPM are primarily involved in producing:

A. energy.
B. spores.
C. toxins.
D. offspring.

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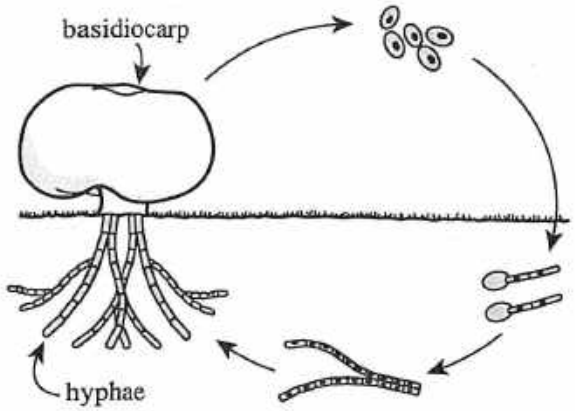
30. Consider the diagram of the life cycle of a GPM shown below.



This diagram is consistent with the discussion(s) of which student(s), if either?

F. Student 1 only
G. Student 2 only
H. Both Student 1 and Student 2
J. Neither Student 1 nor Student 2

31. Based on Student 1's discussion, spore germination can best be described as a process that directly results in the production of new:

A. spores.
B. toxins.
C. hyphae.
D. basidiocarps.

32. Do Student 1 and Student 2, respectively, describe the portion of the GPM involved in obtaining energy as being located aboveground or belowground?

	Student 1	Student 2
F.	aboveground	aboveground
G.	aboveground	belowground
H.	belowground	aboveground
J.	belowground	belowground

33. Based on Student 2's discussion, why do newly formed hyphae separate from parental hyphae *after*, rather than before, the formation of a new basidiocarp?

A. The basidiocarp of a GPM provides energy for other organisms.
B. The basidiocarp of a GPM provides energy for the GPM.
C. The hyphae of a GPM provide energy for other organisms.
D. The hyphae of a GPM provide energy for the GPM.

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Passage VI

A *semiconductor* is a substance whose electrical properties can be fine-tuned by *doping* (replacing some of the substance's atoms with atoms of another substance). *Silicon* is one example of a semiconductor. A scientist performed 2 experiments to study the electrical resistance, R, of silicon *wafers* (thin blocks) that had been doped.

Experiment 1

The scientist placed 15 silicon wafers into a temperature-controlled chamber. The length and width of each wafer was 10.95 mm, and the thickness of each wafer was 0.95 mm. One wafer was pure silicon, 7 of the wafers had been doped with boron atoms, and 7 of the wafers had been doped with arsenic atoms. Each of the boron-doped wafers and each of the arsenic-doped wafers had a different *doping concentration*, N_d (the number of doping atoms per cubic centimeter, atoms/cm^3). The scientist then connected each wafer to a separate *ohmmeter* (a device that measures R). Figure 1 shows this apparatus; for clarity only 1 wafer is shown connected.

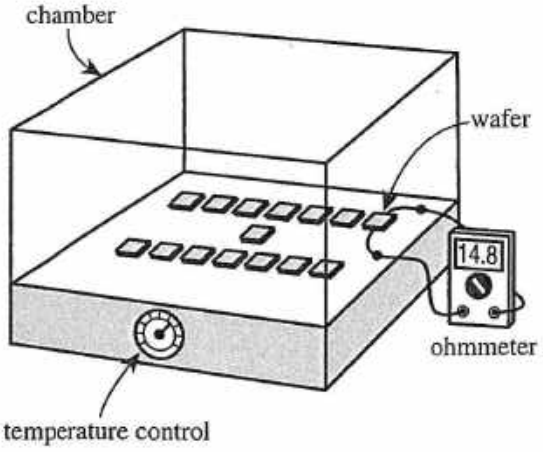

Figure 1

The scientist set the temperature, T, of the chamber at 300 kelvins (K). Then, after the wafers had been in the chamber for 30 min, she measured R (in ohms, Ω) for each wafer. Figure 2 shows R for the doped wafers; R for the pure silicon wafer was 3.2×10^7 Ω.

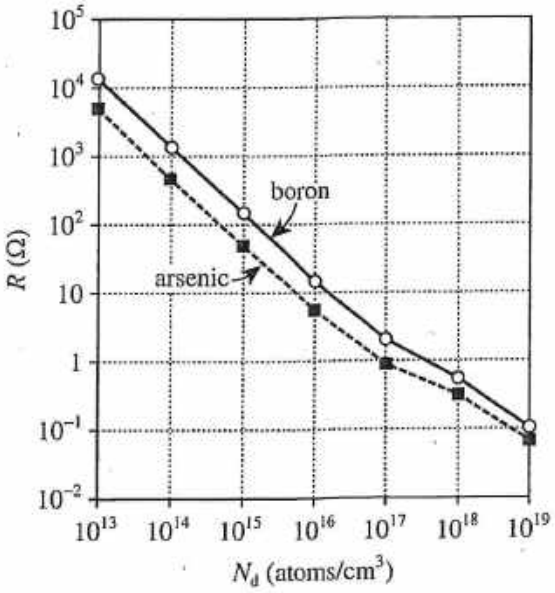

Figure 2

Experiment 2

The scientist removed each wafer from the chamber except for the two having $N_d = 10^{16}$ atoms/cm^3. She measured R for these 2 wafers at various temperatures, waiting 30 min between setting T and measuring R (see Figure 3).

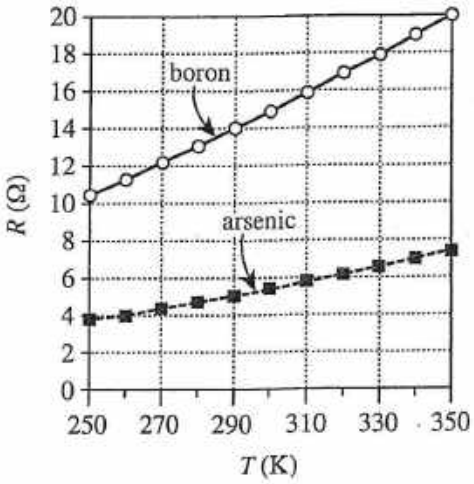

Figure 3

Figures 2 and 3 adapted from Narain D. Arora, John R. Hauser, and David J. Roulston, "Electron and Hole Mobilities in Silicon as a Function of Concentration and Temperature." ©1982 by The Institute of Electrical and Electronics Engineers, Inc.

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34. Suppose that in Experiment 2 the scientist had measured a resistance of 22 Ω for the boron-doped wafer. The temperature of the wafer at the time of this measurement would most likely have been:

F. lower than 340 K.
G. between 340 K and 360 K.
H. between 360 K and 380 K.
J. higher than 380 K.

35. What factor was constant in Experiment 1 but was NOT constant in Experiment 2 ?

A. Resistance
B. Temperature
C. Wafer thickness
D. Doping concentration

36. Based on the results of Experiments 1 and 2, which of the following statements best summarizes the relationship between R and N_d and the relationship between R and T ? R increased as:

F. N_d increased and as T increased.
G. N_d increased and as T decreased.
H. N_d decreased and as T increased.
J. N_d decreased and as T decreased.

37. Did the scientist investigate whether the resistance of a doped wafer is affected by the wafer's dimensions?

A. Yes; the wafers that were tested had different dimensions.
B. Yes; the wafers that were tested had the same dimensions.
C. No; the wafers that were tested had different dimensions.
D. No; the wafers that were tested had the same dimensions.

38. In Experiments 1 and 2, the scientist most likely waited between setting T and measuring R to ensure that the:

F. wafers were in thermal equilibrium with the chamber.
G. ohmmeters were not in thermal equilibrium with the chamber.
H. chamber was in thermal equilibrium with the greater laboratory environment.
J. doping atoms within each wafer were not in thermal equilibrium with the chamber.

39. Based on the results of Experiment 1, the ohmmeter shown in Figure 1 is most likely connected to the wafer doped with which type of atoms and at what doping concentration?

	type of doping atoms	N_d (atoms/cm^3)
A.	boron	10^{15}
B.	boron	10^{16}
C.	arsenic	10^{15}
D.	arsenic	10^{16}

40. Based on the value of R for the pure silicon wafer and the data in Figure 2, does replacing some of the silicon atoms in a silicon wafer with doping atoms make the wafer a better conductor or a better insulator?

F. A better conductor, because the resistance of each doped wafer was less than that of the pure silicon wafer.
G. A better conductor, because the resistance of each doped wafer was greater than that of the pure silicon wafer.
H. A better insulator, because the resistance of each doped wafer was less than that of the pure silicon wafer.
J. A better insulator, because the resistance of each doped wafer was greater than that of the pure silicon wafer.

END OF TEST 4

STOP! DO NOT RETURN TO ANY OTHER TEST.

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Scoring Keys for Form C02

Use the scoring key for each test to score your answer document for the multiple-choice tests. Mark a "1" in the blank for each question you answered correctly. Add up the numbers in each reporting category and enter the total number correct for each reporting category in the blanks provided. Also enter the total number correct for each test in the blanks provided. The total number correct for each test is the sum of the number correct in each reporting category.

Test 1: English—Scoring Key

	Key	Reporting Category* POW	KLA	CSE
1.	A	___		
2.	G	___		
3.	C			___
4.	G			___
5.	D			___
6.	H			___
7.	B			___
8.	F			___
9.	C			___
10.	J			___
11.	D		___	
12.	F		___	
13.	C	___		
14.	H	___		
15.	A	___		
16.	G			___
17.	C	___		
18.	F			___
19.	B		___	
20.	J		___	
21.	B	___		
22.	J			___
23.	A			___
24.	J			___
25.	C		___	
26.	J			___
27.	D	___		
28.	H			___
29.	C			___
30.	F	___		
31.	B			___
32.	H			___
33.	D			___
34.	J		___	
35.	B	___		
36.	G	___		
37.	B			___
38.	F			___

	Key	Reporting Category* POW	KLA	CSE
39.	C			___
40.	J			___
41.	C			___
42.	H		___	
43.	B			___
44.	F	___		
45.	A	___		
46.	F			___
47.	A		___	
48.	J	___		
49.	A			___
50.	H			___
51.	D			___
52.	G	___		
53.	D			___
54.	J			___
55.	C			___
56.	F			___
57.	A			___
58.	J			___
59.	D	___		
60.	J	___		
61.	D			___
62.	H			___
63.	B	___		
64.	F	___		
65.	C			___
66.	G		___	
67.	A	___		
68.	G	___		
69.	C		___	
70.	F			___
71.	B			___
72.	H	___		
73.	B		___	
74.	J		___	
75.	A	___		

***Reporting Categories**
POW = Production of Writing
KLA = Knowledge of Language
CSE = Conventions of Standard English

Number Correct (Raw Score) for:

Production of Writing (POW) _____ (23)

Knowledge of Language (KLA) _____ (12)

Conventions of Standard English (CSE) _____ (40)

Total Number Correct for English Test (POW + KLA + CSE) _____ (75)

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Test 2: Mathematics—Scoring Key

Key	Reporting Category* PHM N	A	F	G	S	IES	MDL
1. B						—	
2. J		—					
3. C						—	—
4. J						—	—
5. D				—			
6. G						—	—
7. D						—	—
8. H	—						
9. B						—	—
10. G		—					
11. A			—				—
12. G			—				
13. B						—	
14. H						—	—
15. C					—		—
16. G						—	
17. B			—				
18. F					—		—
19. E				—			
20. H				—			
21. E				—			
22. J						—	
23. E						—	—
24. H				—			
25. E		—					
26. H			—				
27. D						—	—
28. F		—					—
29. D		—					
30. J	—						—

Key	Reporting Category* PHM N	A	F	G	S	IES	MDL
31. C		—					—
32. K	—						
33. D			—				
34. J					—		—
35. B						—	
36. H						—	—
37. A						—	
38. F					—		—
39. A					—		—
40. K					—		—
41. A			—				
42. J						—	—
43. D						—	—
44. F						—	—
45. B		—					
46. F				—			—
47. C				—			
48. F		—					
49. C						—	
50. G						—	
51. C			—				
52. G						—	—
53. B	—						
54. K						—	
55. E				—			—
56. K	—						
57. E						—	—
58. K			—				
59. D						—	—
60. F						—	

Combine the totals of these columns and put in the blank for PHM in the box below.

***Reporting Categories**
PHM = Preparing for Higher Math
N = Number & Quantity
A = Algebra
F = Functions
G = Geometry
S = Statistics & Probability
IES = Integrating Essential Skills
MDL = Modeling

Number Correct (Raw Score) for:

Preparing for Higher Math (PHM) (N + A + F + G + S)	_____ (35)
Integrating Essential Skills (IES)	_____ (25)
Total Number Correct for Mathematics Test (PHM + IES)	_____ (60)
Modeling (MDL) (Not included in total number correct for mathematics test raw score)	_____ (27)

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Test 3: Reading—Scoring Key

Key	Reporting Category* KID	CS	IKI
1. D	___		
2. G	___		
3. C		___	
4. H	___		
5. B	___		
6. J	___		
7. C		___	
8. F	___		
9. C	___		
10. J	___		
11. A		___	
12. G		___	
13. D	___		
14. J		___	
15. B	___		
16. F		___	
17. C	___		
18. H		___	
19. B	___		
20. G	___		

Key	Reporting Category* KID	CS	IKI
21. C	___		
22. J	___		
23. A			___
24. J	___		
25. C			___
26. F		___	
27. B		___	
28. H			___
29. A			___
30. F			___
31. D	___		
32. G	___		
33. B	___		
34. J			___
35. C		___	
36. F	___		
37. C	___		
38. F	___		
39. A	___		
40. G		___	

***Reporting Categories**
KID = Key Ideas & Details
CS = Craft & Structure
IKI = Integration of Knowledge & Ideas

Number Correct (Raw Score) for:

Key Ideas & Details (KID) _____ (23)

Craft & Structure (CS) _____ (11)

Integration of Knowledge & Ideas (IKI) _____ (6)

Total Number Correct for Reading Test (KID + CS + IKI) _____ (40)

Test 4: Science—Scoring Key

Key	Reporting Category* IOD	SIN	EMI
1. A	___		
2. F	___		
3. C	___		
4. H		___	
5. B		___	
6. J		___	
7. D	___		
8. G		___	
9. D	___		
10. H		___	
11. C	___		
12. F		___	
13. B			___
14. F			___
15. C	___		
16. F	___		
17. B	___		
18. F	___		
19. A	___		
20. J	___		

Key	Reporting Category* IOD	SIN	EMI
21. D	___		
22. H	___		
23. A	___		
24. J	___		
25. B	___		
26. J			___
27. B			___
28. G			___
29. D			___
30. F			___
31. C			___
32. H			___
33. B			___
34. H		___	
35. B		___	
36. H	___		
37. D		___	
38. F		___	
39. B	___		
40. F			___

***Reporting Categories**
IOD = Interpretation of Data
SIN = Scientific Investigation
EMI = Evaluation of Models, Inferences & Experimental Results

Number Correct (Raw Score) for:

Interpretation of Data (IOD) _____ (19)

Scientific Investigation (SIN) _____ (10)

Evaluation of Models, Inferences & Experimental Results (EMI) _____ (11)

Total Number Correct for Science Test (IOD + SIN + EMI) _____ (40)

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Explanation of Procedures Used to Obtain Scale Scores from Raw Scores

On each of the four tests on which you marked any responses, the total number of correct responses yields a raw score. Use the table below to convert your raw scores to scale scores. For each test, locate and circle your raw score or the range of raw scores that includes it in the table below. Then, read across to either outside column of the table and circle the scale score that corresponds to that raw score. As you determine your scale scores, enter them in the blanks provided on the right. The highest possible scale score for each test is 36. The lowest possible scale score for any test on which you marked any responses is 1.

Next, compute the Composite score by averaging the four scale scores. To do this, add your four scale scores and divide the sum by 4. If the resulting number ends in a fraction, round it off to the nearest whole number. (Round down any fraction less than one-half; round up any fraction that is one-half or more.) Enter this number in the blank. This is your Composite score. The highest possible Composite score is 36. The lowest possible Composite score is 1.

ACT Test C02	Your Scale Score
English	_____
Mathematics	_____
Reading	_____
Science	_____
Sum of scores	_____
Composite score (sum ÷ 4)	_____

NOTE: If you left a test completely blank and marked no items, do not list a scale score for that test. If any test was completely blank, do not calculate a Composite score.

Scale Score	Raw Scores				Scale Score
	Test 1 English	Test 2 Mathematics	Test 3 Reading	Test 4 Science	
36	74-75	59-60	40	39-40	36
35	72-73	57-58	38-39	38	35
34	71	55-56	37	37	34
33	69-70	54	36	—	33
32	68	53	35	36	32
31	67	51-52	34	35	31
30	66	49-50	33	34	30
29	65	47-48	32	33	29
28	63-64	44-46	31	—	28
27	62	41-43	30	31-32	27
26	60-61	39-40	29	30	26
25	58-59	36-38	28	29	25
24	55-57	34-35	27	27-28	24
23	52-54	32-33	25-26	26	23
22	49-51	31	24	24-25	22
21	47-48	29-30	22-23	23	21
20	44-46	28	21	21-22	20
19	42-43	26-27	20	20	19
18	40-41	23-25	18-19	18-19	18
17	38-39	20-22	17	17	17
16	35-37	17-19	16	15-16	16
15	31-34	13-16	14-15	13-14	15
14	28-30	10-12	13	12	14
13	26-27	8-9	12	11	13
12	24-25	6-7	10-11	10	12
11	21-23	5	9	8-9	11
10	18-20	4	7-8	7	10
9	15-17	—	6	6	9
8	13-14	3	5	5	8
7	11-12	—	—	4	7
6	9-10	2	4	3	6
5	7-8	—	3	—	5
4	5-6	1	2	2	4
3	4	—	—	1	3
2	2-3	—	1	—	2
1	0-1	0	0	0	1